METAL INDUSTRY

14 MARCH 1958

A Vital Link

SET up by the Board of Trade under the Development of Inventions Act, 1948, to secure the development or exploitation, in the public interest, of inventions resulting from public or private research, the National Research Development Corporation has just issued its report for the year 1956-57. Public research in this context means research carried out by a Government Department or other public body, and any other research in respect of which financial assistance is provided out of public funds. Where the public interest requires it the Corporation may sponsor the development of inventions from private firms or individuals, provided it is satisfied that such inventions are not already being sufficiently developed or exploited. The Corporation can promote or assist research and development work designed to bring on inventions to maturity for commercial exploitation; it can finance the design and construction of experimental models or prototypes; it can finance pilot-scale production.

Not having its own research, development or production establishment, the Corporation may, for further research in a particular case, use the originating laboratory and finance the employment of additional workers. For development it may contract with any organization equipped for the purpose; for pilot scale production it usually turns to industry. In all these fields it may participate in combined operations with research establishments or in joint ventures with industry. But, for exploitation, i.e. production on a commercial scale, it is bound by the Act to turn to the industry concerned, save in exceptional circumstances. Commercial exploitation of a Corporation invention is arranged by the grant of licences on the payment of a royalty. It should be stressed, however, that assessment of the merits of an invention is not solely concerned with its money-making possibilities.

Royalty income continues to show a rising trend, representing a major part of the revenue from exploitation of inventions (£121,889 in the year). The current annual total value of the sales of goods made under licence from the Corporation has now to be reckoned in millions of pounds. At the end of the year under review 335 licence agreements were in force, licensed firms including overseas concerns (some in the United States) as well as United Kingdom manufacturers.

New development projects of particular interest to the metal industry include work on unconventional methods of leaching of ores of special metals which result in the bulk of unwanted constituents being efficiently separated out, leaving a concentrated material from which the metal can be extracted by well-established methods. Further development is being carried out on ion exchange resins which selectively remove gold from dilute cyanide solutions containing that metal in association with impurities. On the laboratory scale work has been undertaken to evaluate a technique proposed by a private inventor whereby certain metals may be extracted from the vapour phase by decomposition of the metal halides in a high vacuum. A prototype mill for the production of ultra thin foil—embodying the results of work at the G.P.O. Research Station—has now been completed and is being demonstrated to interested parties.

Altogether not less than fifty projects and licensed inventions are referred to in the report, ranging from the Bailey bridge, to the freezing of milk and cream; from the towing of oil in flexible containers to a potato harvester; and from electronic digital computers to an aural microscope and chick sexer. More than enough to prove that the N.R.D.C. functions as a vital link between research and industry.

Out of the MELTING POT

Filling a Gap

ELECTROPLATING and electroforming are sufficiently far apart for them rarely to be thought of together. Somebody concerned with obtaining a copper undercoating will not, and quite rightly, think of the electrodeposition of copper as a means of producing copper foil. A broader view, for instance, one encompassing both the deposition of a copper undercoating and the electroforming of copper foil, might show up possibly useful relationships and possibilities. What, for example, are the possibilities of electroplating electroformed foil or sheet? Such idle but occasionally intriguing speculations can be multiplied by increasing the breadth of view still further. Thus, the latter can be extended to include not only electroforming and electroplating, but also electrophoretic coating, and a bit more. This has, of course, been done on more than one occasion and used, for example, to compare and contrast electroplating and electrophoretic coating. Hitherto, however, the breadth of view has not, it would appear, been extended that extra bit more that would show up the absence from the picture of electrophoretic forming as a counterpart to electroforming. Once this absence has been perceived, however, imagination can be set to work to rough in some of the outlines of electrophoretic forming. These include, to begin with, the need for a suitable electrically (surface) conducting support, former or core. One can then visualize the electrophoretic deposition of finely divided metallic or non-metallic materials or, these days, more likely of a mixture of the two (cermets). One can speculate about the thicknesses that could be built up in this way and whether, in the case of non-conducting particles, the process could be assisted by pretreatment to provide surface conductivity. Finally, one can further visualize the delicate operation of stripping the electrophoretically-formed product from the support, and the subsequent firing or sintering, or the direct firing or sintering of the product with the support, the latter either decomposing and being eliminated, or fusing and infiltrating into the product.

Market Development

"IS there a market for them?" asks a recent advertiser in the personal column of *The Times* after claiming to be a prolific source of bright ideas. The answer to this question is not easily given. Market research does not appear to have concerned itself, as yet, with the market for bright ideas. In the absence of facts, can the traditional view of ideas before their time and of struggling, misunderstood, unappreciated inventors and the rest of the familiar picture be accepted by way of an answer? Certainly not. This gloomy picture, just like the enthusiastic optimism associated with a bright new idea, are both equally one-sided. Their one-sidedness stems from their concern with what is equally one-sided, namely, the new idea. On the other side is the question or problem to which the bright idea will provide an answer or solution. Indeed, questions and problems constitute the market in which new ideas can find a sale, and if sales are far from brisk, their failure must be attributed to a neglect to cultivate and develop the market. The extent of this neglect will become clearer after realizing how seldom, if, indeed, ever, one has met somebody enthusiastically brandishing a bright new question or problem he has thought of. In the ordinary course of events, questions and problems are left to find their own way towards recognition. As a result, is it really surprising that the presentation of a new idea is met by the opinion that it is not wanted? The one-sidedness of the situation is probably due to the fact that questions and problems are much more difficult to discover than answers or solutions. This difficulty may be inherent and fundamental; it may be due to some mechanism of our mind, or it may be just due to lack of practice. If it is the latter explanation that is the true one, we had better start practising.

Becoming Real

FOLLOWING the usual delay between vision and reality, plastics-metal combinations are now rapidly turning into the latter. Plastics-metal combinations have, of course, been known for some considerable time, but under such misnomers as cold solders and metal cements have hardly been taken seriously or used for anything more substantial than the filling of dents in car bodies or blow holes in castings. The new compositions, which, by analogy with cermets ought perhaps to be called plasmets, are of sterner stuff and intended for sterner uses. The first of them to be announced as having reached commercial status has found it in the manufacture of sheet metal forming dies. Called Epoxy Alloy, it consists of a heat-resistant epoxy resin reinforced with either low-carbon steel fibres, aluminium fibres, or a combination of glass and steel fibres. When used for dies, the greater strength and wear resistance of the material result in a much longer life than that of plastics materials used for dies hitherto. With the emphasis on uses and performance of Epoxy Alloy, details regarding length and thickness of the metal fibres, their proportion to the resin and other suchlike information seems to have been overlooked. Such details can be found in a recent patent claiming a much wider approach to plasmets:—a composition contaning at least 10 per cent (possibly 10 to 70) by volume of one subdivided non-sintered metal and one or more synthetic resins which are adherent with respect to the metal and which are intimately mixed therewith. The stipulation concerning the metal constituent is that at least half of it should be in the form of fragments, the minimum dimension of which is greater than 0·14 mm. but less than 10 mm. and preferably less than 3 mm. This requirement covers, in addition to granulated metal, chips and flakes, also wires and fibres. The limitation on length is waived in the case of wires and fibres which may be several centimetres in length. If the proportion of metal is allowed to exceed 70 per cent, the proportion of resin may become so small that porous materials will be obtained. In these, the metal content may be as high as 95 to 99 per cent. In connection with the proportion of metal fibres in plasmets, it is interesting to note that, according to a recent discovery, in the case of fine and short glass fibres their proportion in a fibre-resin composition can advantageously be increased beyond the hitherto accepted maximum of about 30 per cent by weight to 90-95 per cent by weight.

Skimmer

PROGRESS IN HEATING FOR METAL MELTING AND THERMAL TREATMENT

Fuel Efficiency

HELD in the Lecture Theatre at the College of Technology, Gosta Green, Birmingham, on Wednesday, February 26, an informal discussion on "Fuel Efficiency in the Melting and Thermal Treatment of Metals" was organized by the Institute of Metals. **Professor H. Ford,** chairman of the Metallurgical Engineering Committee of the Institute, occupied the chair.

At this meeting the discussion was opened by two addresses, one from **Mr. F. C. Ashen** (Imperial Chemical Industries Ltd., Metals Division), who dealt with the relative merits of various types of fuel, and the other by **Mr. P. F. Hancock** (Birlec Ltd.), who dealt with those aspects of fuel efficiency that apply to electric furnaces.

DISCUSSION

F. C. Ashen (Imperial Chemical Industries Ltd., Metals Division):

In the non-ferrous metal industry, furnace equipment, except for special melting shops, must now be in the flow line of production, and solid fuel is being replaced by the derived fuels, gas and electricity, and liquid fuel from the pipeline.

The type of fuel which has replaced solid fuel is the first important factor in the fuel balance sheet.

Solid fuel fired equipment could have only a low thermal efficiency, but it had the merit of being direct. Both gas and electricity lose something in their own manufacture, and to maintain the same overall efficiency they must make good this loss by having a high applicational efficiency.

A mean efficiency for solid fuel fired furnaces would be about 15 per cent, so gas with a conversion efficiency from coal of 75 per cent must maintain an applicational efficiency to the process of 20 per cent to break even with the direct burning of coal. Electricity, with a conversion efficiency of, say, 25 per cent, must maintain an applicational efficiency of 60 per cent to break even.

When electricity was first competing on a commercial scale, the efficiency of conversion could only be taken at 20 per cent at the most, so an applicational efficiency of 75 per cent was needed. The realization of this fact was driven home by the coal shortage during the war years, and this, quite apart from the high cost of electrical energy, made fuel and furnace people efficiency conscious for the first time.

When new fuels took the place of coal and coke there were so many obvious advantages with the new equipment that it was easy to ignore the fuel waste.

Even to-day, when all are fuel minded, it is extremely difficult to know in precise terms what the state of fuel economy is. Measurements of work throughputs are difficult to get over long periods and, although it is comparatively easy to measure fuel supplies, individual processes are rarely separately metered, and if it so happens that all the facilities for measurement are available, there is the business of collecting and collating and analysing the data, and presenting it to higher authority in such a way as to make the management think the cost is worth while.

Choice of Fuel

Keeping the overall efficiency of fuel in mind, the first consideration should be the choice of fuel and a suitable appliance to suit the production practice.

When it comes to choice between the two derived fuels, gas and electricity, there should be little doubt as to which should be adopted. Melting by induction heating has so many metallurgical advantages that it has the copper and copper-base alloy field nearly all to itself—and it can compete in its overall efficiency with the direct coke firing of crucible pots.

The same can be said for final heat-treatments to close temperature tolerances, or where products of combustion cannot be allowed to mix with the charge. But if electricity is used where wider tolerances of temperature can be allowed and the products of combustion are not detrimental to the charge, then it can be suspected as creating a fuel waste.

A few years ago it seemed that gas and oil, because of their combustion characteristics, had their own particular fields of application almost as clearly defined as electricity has, but recent development in combustion techniques has changed the picture entirely.

There is no need to be bothered by the combustion phenomena of flame from the burning of either gas or oil. Flameless combustion of gas by surface combustion has been known for a long time, and used to give uniform radiating surfaces, but it is only a weak relation to the powerful high intensity combustion which now issues streams of high velocity hot gases from the nozzle into the heating chamber.

When considering the application of heat at the highest potential, the choice of fuel and method of application become all-important. It would be foolish, for example, to fire a copper refinery with a low calorific producer gas, as the combustion gases sweeping the tap hole near the stack need to be about 1,250°C. and they would be carrying away at least 80 per cent of the heat of the fuel, leaving only 20 per cent to do the work, whereas with a fuel oil of higher calorific value only about 60 per cent of its heat would be lost up the stack. Far better to use the producer gas for firing an aluminium reverberatory melting furnace with gases leaving at, say, 800°C., when only 50 per cent of the heat would be going away, leaving 50 per cent available for work.

Heat recovered by recuperation from the heat of flue gas is quite an important factor in thermal efficiency, but it is not just a straight reckoning of saving by what is taken out of the waste gases. All sorts of involved reactions occur when air for combustion is pre-heated. The luminosity of the flame is decreased, which reduces the efficiency of the flame as a heat-transferring medium, but its combustion rate is increased and can be more complete within the heating chamber, with all the consequent advantages of greater gas radiation, better radiation from unshielded brickwork, and a reduction of unburned gases in the flues.

All the advantages of heat recuperation, however, can be lost unless strict attention is paid to the elimination of excess air, which is far less noticeable when burning liquid fuels with pre-heated air than it is with cold air. Unheated excess air tends to make the flame of heavy oil less dense and have a scattered brilliance, which becomes a shower of sparks with extreme amounts of excess air. This does not happen with pre-heated air.

Oil Fuel

Liquid fuels are usually chosen for particular processes by consideration of the cost and scale of application. Heavy oils and creosote pitch mixtures need a considerable amount of equipment to bring them pumped at the right pressure and temperature to the burner. Consequently, only large scale usage warrants the expense, and usually large scale usage of the heavy fuels is applied to the melting processes in reverberatory-type furnaces where the higher luminous flame of the heavier liquid fuels is an advantage. At the other end of the scale, a small melting pot can be supplied with a cold, light oil, fed by gravity, which burns easily in the restricted space around the pot, with a less luminous flame which minimizes the effect of flame impingement and damage to the pot. In between, come the medium oils for pre-heating and interstage annealing, on a medium scale of usage and needing a medium amount of equipment, and, unless special precautions are taken, only giving medium satisfaction.

A guide as to the character of the flame of all liquid fuels is the carbon hydrogen ratio. The carbon remains about the same, at 85 per cent, in the petroleum residual fuel oils, but the hydrogen varies from about 10·5 per cent with heavy oil to 13 per cent in the lighter. With the tar oils, the carbon is 89 per cent in the equivalent heavy grade, and the hydrogen only 6·5 per cent. This wider ratio gives a much brighter luminosity, and it has been found on large-scale usage for high-temperature processes that it gives a consistently higher efficiency which can only be attributed to the different flame condition.

Oil burners have been developed to proportion the air and fuel with a single lever control, and maintain a constant velocity of gas emission for high and low rates of burning. They can be pyrometrically controlled. So, also, can the pressure regulated systems, but the constant velocity type has great advantages. More developments may be expected with flame type oil burners towards better control of air and oil ratios, better mixing, and less flame.

Even with the simplest type squirt burner, if the pressure in the chamber can be regulated so that the velocity of the oil and air spray induces the combusted gases to re-enter the flame, or what would be the flame, all luminosity

is suppressed and what seems like a perfectly uniformly-heated chamber is the result. The atmosphere is slightly reducing under these conditions, but not sufficient to cause gassing.

Flameless combustion of oil would eliminate many problems. But the question with it, as often occurs at the beginning of new developments, is how to make out the economic case for substituting it for old equipment if the old equipment is reasonably efficient.

The flameless combustors and oil gasifiers which have been developed over the past few years, although used in many other trades, have not as yet, as far as is known, replaced any conventional type equipment in this country.

Gaseous Fuel

Industrial gas is now almost wholly Town's gas. Producer gas served its purpose in isoated sites when Town's gas was unobtainable.

An advantage with producer gas is the convenience of using injector type burners for firing chambers which permit a slight negative pressure. Producer gas, being almost the same density as air, can easily induce its one-to-one ratio of combustion air with more precision than any device of natural air inducement for Town's gas. This one-to-one ratio of gas to air ensures a rapid intermix, and it is an advantage to have the rapid diffusion of heat for uniform transfer to materials only requiring low-temperature heat-treatment.

Along with producer gas, pulverized fuel firing for smaller units is a disappearing firing method. The reason is principally one of convenience. Pulverized fuel can do its work for heavy duty and high-temperature firing with as good a thermal efficiency as oil, but oil storage supply lines and burners are so much easier to install and maintain than the equivalent equipment for pulverized fuel.

Town's gas is really the maid of all work. Unfortunately, in most appliances it is too easy to waste, either by the amount of excess air, which does not show too clearly from combustion appearances, or from the unburned gases in the flue or those which escape from the furnace in other ways and show as carbon black on chilled surfaces.

The early gas-fired furnaces which replaced coal-fired equipment suffered badly in both respects and, as they mostly retained the muffle chamber to keep the products of combustion away from the charge, the heat transfer condition remained unaltered and there was little advance in thermal efficiency. All this has changed over the past few years and, except for aluminium alloys susceptible to combustion gases, all chambers can be directly fired. This not only enhances the efficiency of the heat transfer process, but provides the atmosphere to protect the metal surface, which is what the muffle was supposed to do but did not.

Furnace Performance

There was a time when furnace design was based on empirical figures of so many lb/ft^2 of hearth area/hr. For brass rolling slabs a figure of 70 lb. was used to allow plenty of time for good temperature equalization to take place throughout the metal, because at some stage of the heating wide temperature differences would exist. Even soaking periods used to be mentioned where no phase changes were involved. Soaking was thought very necessary for all extrusion processes because uneven heating caused non-uniformity of sectional area.

However, when it became necessary to increase the production rate of an extrusion press fed by a small oil-fired furnace, experiments were made to find out what the heat absorption rate of a 5 in. diameter brass billet could be, consistent with a suitable temperature distribution throughout the billet.

It was found that by having everything in favour of a rapid heat exchange, by using a small chamber with high-temperature radiating surfaces, with the most violent scrubbing action of the gases, the billet could be raised to a surface temperature of 820°C. in 6 min., but with a temperature difference at the centre of 50°C. A slower rate of firing over a period of 20 min. gave a temperature difference of only 10°C.

This was thought satisfactory. It would equalize going to the press, and the furnace was redesigned using concentrated combustion burners counting on a 240 lb/ft^2 hearth loading. It gave a ton an hour of uniformly heated billets at 730°C. with a fuel consumption of 1,470 ft^3 of gas per ton, including the wastages for one idle shift per day and losses at the week-end. The overall efficiency was 48 per cent.

A furnace converted from diffused Town's gas firing to concentrated combustion firing for a 5 ton/hr. output of ½ ton copper rolling slabs at 650°C. gave a performance of 1,100 ft^3/ton and an efficiency of about 55 per cent.

Another copper wirebar furnace, converted from direct coal firing to concentrated combustion firing, gave 2 tons/hr. at 900°C. for a gas consumption of 1,800 ft^3/ton; an efficiency of about 50 per cent.

A number of batch annealing furnaces converted from semi-producer gas firing gave an output of brass strip at the rate of about 1 ton/hr. for a gas consumption of 1,020 ft^3/ton; an efficiency of about 55 per cent.

Only one example of comparative details for three furnaces will be given, all batch types doing the same work; a semi-producer type, a Town's gas concentrated combustion fired type, a conversion from a semi-producer type, and an electric metallic resistor type with disturber fans.

All were good performers, and tests were done over a sufficiently long period to get reliable figures. Their respective performances per ton of metal annealed were: 1¼ cwt. of coal, 1,000 ft^3 of Town's gas, and 90 units of electricity. In terms of therms of basic fuel according to the conversion factors at that time, they would be: 17·5 therms for coal, 6 for gas, and 17·2 for electricity. The direct therms of electricity applied were only 3·1.

Usual figures for copper refining in a 20-ton bath run between 10 per cent and 13 per cent fuel to metal melted, working on a 24 hr. cycle. The cycle could be reduced, but it would disturb the man shifts and supervisors' hours. One way of putting the cycle in better balance is to increase the bath capacity. Before the use of oil, coal firing suited the 20-ton size of bath, and when they were converted to oil, one refinery increased the bath capacity to 30 tons to avail themselves of the extra pep of oil firing. Their fuel consumption figures are better without any extra attention and usually do not rise above 10 per cent.

In terms of efficiency, 10 per cent of fuel to metal is about 24 gal/ton of oil, giving an efficiency of about 16 per cent and a 13 per cent ratio of fuel to metal is coincidental at 13 per cent efficiency.

A 10-ton rotary furnace can get down to a 7 per cent ratio of fuel to metal with continuous melting. In appearance it looks shockingly inefficient because of the smoke and flame which is belching out for most of the melting time. Any attempt to keep the flame inside the chamber by reducing the oil rate extends the cycle, and the efficiency is not so good. It is a clear case for using highly preheated air for shortening the flame, or using one of the new concentrated combustion techniques.

P. F. Hancock (Birlec Ltd.):

Fuel efficiency in metallurgical processes may be defined as: the actual heat requirement of the material undergoing process divided by the total energy in the fuel employed, multiplied by 100. Thus:—

$$\text{Efficiency per cent} = \frac{\text{Heat requirement of material}}{\text{Total heat in fuel employed}} \times 100$$

The top term on the right-hand side, in straightforward metal melting and heat-treatment operations, is normally the total sensible heat of the metal at its casting or treatment temperature less the total heat at room temperature. This may need suitable correction if the process involves any temperature cycling; equally, if any refining or other chemical reactions are involved, the heat of these reactions must also be taken into account.

The bottom term on the right-hand side, for the purposes of this discussion, is assumed to be the power drawn from the factory main supply for the operation in question. For a basic assessment in terms of utilization of fuel, one might also take into account the conversion efficiency of fuel to electric power at the power station, which, for thermal stations to-day, varies between about 22 per cent and 31 per cent. But since this factor lies outside the control of the furnace designer or operator, it will not be considered further.

In electric heating, the unit of energy employed is the kilowatt-hour, which is equivalent to 3,412 B.Th.U. or 860 Kilogram Calories:

1 kWH≡3,412 B.Th.U.≡860 Cals.

The basic equation above may also be written:—

$$\text{Efficiency per cent} = \frac{\text{Heat content}}{\text{Heat content} + \text{Losses}} \times 100$$

The second item in the term on the bottom right-hand side includes all that part of the total energy which is not usefully employed in heating the material undergoing process, and which may, therefore, be broadly categorized as "losses."

For a specified process, nothing can be done about the "Heat content" term, except by recuperation. For electric heating, in which there is no combustion, and, therefore, no flue products, the only form of recuperation which can be considered is "charge recuperation," i.e. heat interchange between the treated charge and the new charge. For batch operation this is rarely worth while, since the potential saving does not usually exceed 10 per cent of the useful heat, and this is achieved only at the expense of complication of the equipment and additional

TABLE I—HEAT BALANCE FOR ARC FURNACE

Consumption	per cent	kWh/ton
Useful heat	62	370
Electrical losses	7	
Wall losses (including roof)	14	
Door losses	7	
Water cooled furnace parts	5	
Escaping gases	5	
Total energy consumed		595

Overall efficiency 62 per cent

TABLE II—H.F. CORELESS INDUCTION FURNACE

1-ton furnace rated at 600 kW H.F. (1,000 c/s) power

	kWh	per cent
Net heat content at 1,500°C.	368	
Losses in motor alternator	90	
Losses in busbars and capacitors	16	37
Losses in furnace coil	116	
Wall and top losses	40	6
Total energy consumed	630	

Overall efficiency 58 per cent

handling. In continuous operation, a larger saving may be possible (in favourable circumstances up to 35 per cent) by use of counterflow methods. But in this case again, complication of equipment and handling may militate against its use. A further objection may be contamination of the treated charge by decomposition products of lubricants volatilized from the new charge.

Broadly speaking, then, the consideration of fuel efficiency in electric heating comes down to an examination of "losses" and how they may be minimized.

Factors Affecting Losses

Consider the various items which may go to make up the total of "losses." Some of these are primarily in the hands of the equipment designer, while others are affected rather by the method of operation.

Losses in electrical equipment would be losses in cables and transformers; in the case of induction furnaces, also in high frequency generators, if employed, capacitors and furnace coils. The permitted losses in standard electrical components and equipment are laid down in the relevant British Standards and are, therefore, largely outside the control of either furnace designer or operator. The ratio of this item to the total "losses" may vary from negligibly small in the case of a resistor furnace connected straight on mains, where the only losses are in cables, to a high figure in the case of, say, an induction heater for aluminium billets, where the coil losses may be up to two-fifths of the total energy consumption.

In many thermal treatment operations, conveyors, trays, boxes or fixtures must be employed for handling the charge in the furnace, and heat supplied to such components must be classified as losses of energy for heating deadweight. The extent of this item depends partly on furnace design, e.g. in employing a type of conveyor in a continuous furnace which has minimum ratio of dead weight to charge weight; but partly also on operating practice, e.g. in ensuring that the conveyor is loaded to the fullest permissible extent.

In the case of furnaces used intermittently, the heat consumed in raising the furnace to operation temperature after a shut-down should also be included here.

Heat losses by conduction through furnace walls are almost entirely in the hands of the furnace designer (provided always that the user subsequently keeps the furnace in reasonable repair), but the type and thickness of refractories must generally be a compromise. For furnaces which are to operate continuously at fixed temperatures, heavy insulation is desirable. On the other hand, if the furnace is to operate intermittently, or the process involves temperature cycling of the furnace, too heavy insulation may defeat its purpose, since the heat content of the additional refractories may exceed the savings resulting from lower conduction losses. Sometimes, other considerations may dictate a thinner wall than is desirable purely from the point of view of conduction losses. Thus, insulation of an arc furnace roof may result in overheating and short life of the roof refractories. Again, in an induction furnace the coil must be as near as possible to the charge for maximum coupling to be obtained, and the refractory thickness is usually reduced to the minimum in the relevant regions; savings in conduction losses by a thicker wall would, in this case, be more than balanced by the greater relative coil losses resulting from looser coupling.

With furnace door losses, the furnace designer has his part to play in providing well-fitting, well-insulated doors which will minimize losses in the closed position. To ensure efficient use, however, the operator must also see that doors are opened only for the minimum time necessary for charging and discharging, or in continuous furnaces that the height of opening is no greater than sufficient to allow safe passage of the charge

It may sometimes be necessary to water cool (or air cool) certain vulnerable furnace parts, for example fan shafts and bearings, doors and door surrounds. Additional heat loss so occasioned is acceptable if offset by reduced maintenance and greater continuity of production. In the case of induction furnaces, forced cooling of the furnace coil is usually essential, particularly in view of the close proximity of the coil to the heated charge referred to above, and the high current density it is necessary to employ.

In furnaces for thermal treatment employing controlled atmospheres, some heat is employed in raising these gases to furnace temperature. For gases commonly used, about 1 kWh/1,000 ft³/100°C. rise in temperature is required. In large continuous-annealing furnaces, this item can assume considerable proportions, but may be minimized by intelligent design and operation. Thus, the major requirement of atmosphere volume is for keeping the end openings purged, and there is no need to insert more than a small amount of the total flow into the heating chamber.

While heat losses may arise in other ways, in special circumstances or with particular types of furnace, the above are the principal items making up the total and by the reduction of which fuel efficiency may be enhanced.

Typical Examples

Some typical electric furnace operations may be considered to show how the losses arise and what efficiency can be expected.

In an arc furnace for steel making, an approximate heat balance for the arc furnace (2-ton size) on acid practice is as shown in Table I.

No account is here taken of heat content of slag-making materials. The net efficiency may thus be somewhat less than the figure shown, depending on operating practice.

In an H.F. coreless induction furnace for steel melting, a heat balance, as in Table II, could be drawn up.

It is interesting to note that a mains frequency coreless furnace of the same rating but somewhat larger capacity (2 ton) may, in similar circumstances, be expected to show an overall efficiency of about 62 per cent, slightly higher coil and other electrical losses being more than counterbalanced by elimination of the motor-alternator set.

In the channel type induction furnace for brass and bronze melting, total electrical losses should not exceed about 10 per cent of the total energy consumption. Thermal losses from walls, inductor tunnel and lids account for a further amount varying between 10 per cent and 25 per cent, according to the size of furnace, the melting rate, and the casting temperature. Overall efficiency thus lies between about 80 per cent and 65 per cent.

The lower electrical but higher thermal losses of this type of furnace as compared with the coreless furnace may be noted.

In a continuous pusher-type furnace for reheating aluminium alloy slabs with an output of 3 tons/hr., an hourly heat balance would appear, as in Table III, assuming the following features: twin-track furnace, 21 ft. heated length; forced circulation; rating 750 kW; operating temperature 550°C.

The figure in Table III is computed on continuous operation. Allowing for a week-end shutdown of 48 hr. and the stand-by losses occasioned thereby, the overall efficiency would become 68 per cent.

In a continuous pusher-type mains

TABLE III—HOURLY HEAT BALANCE FOR REHEATING FURNACE

	kWh
Net heat to slabs (3 × 160 kWh/ton)	480
Electrical losses (fan motors)	9
Heat to conveyor shoes	65
Wall losses (including metal hearth supports)	103
Door losses (8 openings/hr.)	20
Total energy consumed	677

Overall efficiency 71 per cent

TABLE IV—HEAT BALANCE FOR BILLET HEATER

	kWh	per cent
Net heat to billets (1½ × 160)	240	
Electrical losses (busbars, transformer, capacitors)	33	6½
Coil losses	200	42
Thermal losses to coil	7	1½
Total energy consumed	480	

Overall efficiency 50 per cent

frequency induction heater for aluminium alloy extrusion billets, with an output of 1½ tons/hr. and an operating temperature of 550°C., the hourly heat balance would be as in Table IV, assuming a 100 in. long coil and three 8 in. diameter by 33 in. long billets in coil.

As the figures in Table IV indicate, the comparatively low efficiency is due to high coil losses (42 per cent), resulting in turn from the high electrical conductivity of the charge. It may be noted that a corresponding operation on heating steel billets to 1,250°C. would yield an overall efficiency in the region of 55 per cent, in spite of the much larger thermal losses (14 per cent).

For bright annealing coiled copper wire in a bell type furnace having an output of 1·33 tons/hr. and a temperature of 450°C. (5 ft. diam., 3 ft. 6 in. high charge space, 4 ton charge), the heat balance per charge (electrical losses and heat to atmosphere gases negligible) would be:—

	kWh
Net heat to charge (4 × 54 kWh)	216
Heat to hearth, bell and container	88
Wall losses	42
Total energy consumed	346

Overall efficiency—62 per cent.

For bright annealing copper wire on spools in a continuous pusher tray furnace (output 1·5 tons/hr. net (plus 0·2 ton/hr. spools), temperature 500°C.), the hourly heat balance would be:—

	kWh
Net heat to charge (1½ × 60 kWh)	90
Heat to spools and trays	25
Wall losses	17
Door losses	7
Heat to atmosphere gases	6
Total energy consumed	145

Overall efficiency—62 per cent.

The very similar efficiences in these two types of furnace on essentially the same process may be noted. For the same temperature, and with the wire in coils, the continuous furnace would show a somewhat higher figure of 67 per cent.

In conclusion, it may be pointed out that fuel efficiency is not an end in itself, but only one means towards the ultimate end of production at the lowest cost for the specified quality of product. Any contemplated changes in furnace design or operation for the purpose of promoting higher fuel efficiency must always be examined to ensure that any resulting increases in other cost factors, such as labour, floor space or depreciation, are not such as to outweigh the lower fuel cost.

(To be continued)

Men and Metals

A subsidiary of Sheepbridge Engineering Limited, Hardinge Machine Tools Limited announce the appointment of **Mr. L. L. G. Vaughan** as sales office manager.

It is learned from the Steel Company of Wales Limited that **Mr. M. C. Harrison** has been appointed manager of the new Bessemer steel plant which is now under construction at Abbey Works. He assumed his new duties on March 1 last. The company has also announced the appointment of Mr. P. Truscott to be assistant manager of the plant.

To deal with increasing tool steel business in London and the Home Counties, Uddeholm Limited, the British associates of Uddeholms AB, have appointed **Mr. S. A. Comley** as London area manager, tool steel division. Mr. Comley has been the company's tool steel representative in the Birmingham territory for the past five years. He will be succeeded in Birmingham by **Mr. A. G. Shaw.**

A member of the Firth Cleveland Group, the Nottingham firm of Landmaster Limited has appointed **Mr. Arthur Booth** director and general manager of the company.

The Derby firm of Refractory Mouldings and Castings Limited have now appointed **Mr. J. F. Gardner** as their representative for the Northern areas. Mr. Gardner will be located at Gosforth, Newcastle upon Tyne.

It has been announced by Baldwin Instrument Company Limited that **Mr. John D. Thornley** has been appointed as Northern England representative of the company's fluid power division. Mr. Thornley will be operating from Waterhey Cottage, Rivington, nr. Bolton, Lancs.

Correspondence

Correspondence is invited on any subject considered to be of interest to the non-ferrous metal industry. The Editor accepts no responsibility either for statements made or opinions expressed by correspondents in these columns

The Presentation of Metallurgical Information

TO THE EDITOR OF METAL INDUSTRY

SIR,—Whilst one hesitates to disagree with one of Dr. Jenkin's eminence, his views on the presentation of written metallurgical information do seem questionable.

Not everyone would agree with his treatment of his examples. Many of us *do* say "tin, copper-and-nickel" in normal conversation (as distinct from the style used in lecturing). The use of a comma followed by "and" constitutes a double pause between the nouns; this is unnecessary.

Dr. Jenkin's examples taken from a syllabus betray the real faults: bad wording and bad setting-out. No amount of juggling with the accepted rules of punctuation can mitigate such evils.

The counter-suggestion, then, is that we make a more serious study of the rules of good, clear English. The applications would extend far beyond the province of metallurgy — even beyond that of science and technology as a whole.

Yours, etc.,

I. W. C. Cosens.

8 Eastgrove Road,
Sheffield 10.

IMPROVED METHOD FOR REMOVING OXIDES PROIR TO FABRICATION

Cleaning Molybdenum

A PRACTICAL means for removing the oxides from molybdenum has been devised by the Ryan Chemical Laboratory of San Diego, California. Because of its importance in high-temperature applications, molybdenum has been the subject of many investigations to overcome problems involved in putting it into production. Up to the present, there has been no good low-temperature means for cleaning the metal, particularly for removing surface oxides, prior to welding. Many methods for cleaning molybdenum are not satisfactory, either because they attack the metal or are unsafe for personnel.

One method used calls for a molten salt bath of 70 per cent sodium hydroxide and 30 per cent sodium nitrite, operating at a temperature of 500° to 700°F. This method of cleaning is hazardous to personnel because of the dangers in using molten salts. The bath attacks molybdenum, and very close control is needed to prevent excessive metal loss. Losses up to 3 mils have been experienced with 5 sec. immersions.

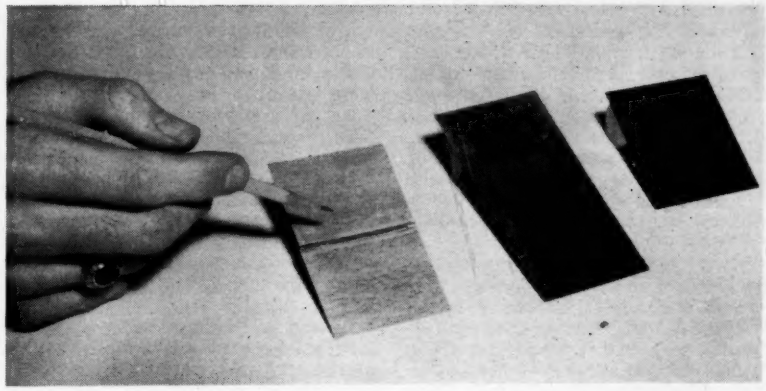
Following descaling of the molybdenum with molten salt, a bath consisting of concentrated sulphuric acid containing 3·5 per cent of a saturated sodum dichromate solution is used for chemical cleaning of the metal. The molten salt bath achieves descaling, but a secondary cleaning operation is usually necessary.

An anhydrous bath has been suggested, composed of 95 per cent sulphuric acid, 4·5 per cent nitric acid, and 0·5 per cent hydrofluoric acid, operated at 195°F. This bath is not completely satisfactory in its cleaning operation and it is difficult to keep the solution anhydrous.

A 25 per cent nitric acid, 2 per cent hydrofluoric acid by volume deoxidizing bath works quite well to remove the oxide, but readily attacks the molybdenum after the oxide has been removed. Electropolishing of molybdenum in 80 per cent sulphuric acid and 20 per cent phosphoric acid by volume has been tried, and although deoxidizing was accomplished, a great amount of metal attack was observed.

It is also possible to deoxidize molybdenum by mechanical means such as sand blasting or vapour blasting. However, this operation is not feasible on complex formed parts, because of the possibility of sand entrapment. Furthermore, its high cost, which arises from the number of man-hours expended per part, often makes it use prohibitive.

The Ryan process involves two chemical baths, which satisfactorily remove all oxides without attacking the base metal. Because molybdenum is resistant to attack from aqueous alkaline solutions, the first bath consists of a deoxidizer with sodium hydroxide as its main constituent. By adding potassium permanganate to this solution, a very strong oxidizing bath was obtained.



Dark sample at extreme right is molybdenum after first bath, centre after second bath, and left, after final spray rinse

Chemically, this bath converts the oxides of molybdenum to a higher valence state, which is easily removed by a pressure spray rinse, leaving only a black smut on the surface of the base metal. The second bath, consisting of acids which do not attack molybdenum, removes this smut and produces a chemically clean surface.

The Ryan alkaline bath consists of 10 per cent sodium hydroxide, 5 per cent potassium permanganate, and 85 per cent water by weight. The solution is kept at 150°-180°F., with length of immersion time set at 5 to 10 min.

The range of operation of this oxide-converting bath is quite wide, and is more dependent on the concentration of the sodium hydroxide than the potassium permanganate. At the present time it appears that the ratio of sodium hydroxide to potassium permanganate cannot be less than 2:1 if an efficient bath is to be attained. The success of the bath comes from the formation of a highly oxidizing mangani-manganate complex which is formed from the reaction of the sodium hydroxide with the potassium permanganate. This complex can also be obtained if sodium hydroxide is fused with manganese dioxide, then dissolved in water.

The smut-removing bath is composed of 15 per cent sulphuric acid, 15 per cent hydrochloric acid, 70 per cent water plus 6 to 10 per cent weight/volume of chromic acid. The solution is kept at ambient temperature with immersion time set at 5 to 10 min. The bath is adequate if the oxide is completely converted by the caustic bath.

The baths have been found satisfactory for deoxidizing prior to fusion welding, and they are believed to be applicable wherever deoxidizing is required in the fabrication of molybdenum.

STANDARD SPECIFICATIONS

Glossary of Terms Relating to Powders (*B.S.*2955:1958). *Price* 4*s.* 6*d.*

A NUMBER of selected terms applicable to metallic and non-metallic powders are defined in this standard. Following a definition of powder (arbitrarily decided upon as "discrete particles of dry material of size less than 1,000 microns maximum dimension") are sections containing terms associated with: Types of powder; Particle size; Particle shape; Powder properties; and Powder processing.

The two appendices to the standard deal with "Mean diameters of particulate systems" and "Calculation of Stokes's diameter" respectively. A full index is included.

Copies of the above-mentioned standard may be obtained from the British Standards Institution, 2 Park Street, London, W.1.

EARLY NON-FERROUS WORK OF SIR HENRY BESSEMER

Metallurgical Pioneer

SIXTY years ago this month, on March 15, 1898, at the age of 85, Sir Henry Bessemer, F.R.S., died. His immense genius as an engineer and the association of his name with the Bessemer process for the manufacture of steel seem almost to have obliterated the facts that he was already in his 43rd year and had more than 40 patents to his name before he took out his first patent connected with the Bessemer process. This article will deal with his little-known work in the non-ferrous field.

His father, as well as being a craftsman, was of an inventive turn of mind, and as a result of his ability to cut "beautiful letter punches" ultimately became partner in a type foundry. In his autobiography[1] Sir Henry writes: "The knowledge of metal work which I acquired in this foundry assisted . . . in fostering that taste for casting and other metallurgical works in which . . . I took so deep and abiding an interest."

The type metal made by his father was superior to that produced by other type founders, and it took Henry little time to discover that the secret was the addition of tin and copper to the ordinary lead-antimony alloy, and for many years afterwards he seemed to have a considerable interest for this class of alloy.

Precision Casting Experiments

On moving to London at the age of 17, with his parents, he began making experiments to reproduce, in metal, plants and flowers. This he accomplished in an alloy of "antimony, iron, bismuth, and tin," after developing for his moulds a satisfactory refractory of powdered limestone, dust of Flanders brick and a small quantity of Plaster of Paris, in which he invested the object to be produced. After suitable drying, the mould was fired to remove the object and the molten metal poured in via a tall runner or gate, the whole being kept in the molten condition for half-an-hour so that the metal filled the mould so perfectly "that the fine pile on the back of a leaf and the tiny prickles on the stem of a rose were all produced as sharp as needle-points."

Not liking the appearance of the alloy, he then experimented with the deposition of a coating of copper by a simple replacement process, finally achieving the desired result by immersing the castings after suitable cleansing in a shallow zinc tray containing a mixture of copper sulphate and nitrate solutions, which surely must rank as one of the earliest examples of the "useful" deposition of copper. He also learned that by additions of distilled verdigris to the solution he could produce an imitation antique bronze coating. A number of examples of his skill with this technique of casting and then coating with "bronze" were exhibited in London museums for many years.

He experimented also with the lost-wax process, and made his first commercial venture with cast dies for stamping impressions in cardboard and leather that were widely used by bookbinders and stationers.

Still not yet 21, he invented, as a result of a remark by the lady whom he subsequently married, the system still used of "dating" official Government stamps to prevent forgery. These can be seen on the 2d. stamp on every cheque, where the month and year of stamping are incorporated. A little later on, by experimenting with heat and pressure on plumbago dust, he developed the filling for "black lead pencils" which is still used.

When 25 years old, Bessemer invented a casting machine for type in which the metal was pressure cast in water-cooled steel moulds. The difficulty of air being trapped in the minute moulds was overcome by exhausting the air in them by means of a vacuum receiver connected to the machine, probably the earliest example of vacuum casting. White metal alloys were also developed for various other forms of die and, most ingeniously, a series of alloys with melting points differing by 10°F. steps which he used for measuring and controlling the temperature of the rolls of a machine for embossing Utrecht Velvet where the temperature required was critical.

Bronze Powder Production

None of these inventions made his fortune, but they nevertheless provided him with a good living. However, it was the purchase of a small quantity of "bronze" powder, the cost of which astonished him, that turned his inventive mind into the fruitful channels of making bronze powder which made for him a sizeable fortune and, in turn, gave him the capital to develop subsequently the Bessemer steel process.

Till then, the powder had been made by a laborious hand process, which was responsible for the high price. Bessemer soon realized that he could not copy the process by machine, and set about inventing a new method. His first method consisted of impressing knurled rollers into a revolving brass disc, the pyramids thus formed then being shaved off by a simple turning tool. This "powder," however, lacked the lustre or texture of the usual bronze powder. Some time afterwards, comparison of the normal powder under a microscope with that he had manufactured instantly showed him the basic difference in shape and thus the cause of his previous failure to reproduce a lustrous powder.

Ultimately, he hit on the method of making needle-like filaments of brass, about $\frac{3}{8}$ in. long, by a technique similar to his former method. The matted filaments produced were then rolled in chilled iron rolls (12 in × 18 in.) after mixing with a little olive oil, this mixture being passed and repassed until a leafy, flaky powder formed. Polishing was accomplished by allowing the powder to fall from a height of 5 ft. to 6 ft. many times, and final grading into the ten grades demanded by the trade was carried out by gently blowing the powder into a long "tunnel," where it automatically graded itself by the position in the tunnel at which it settled. He supplied "pure copper powder" made this way for many years to Elkingtons of Birmingham for metallizing the surface of non-metallic moulds used in their electrodeposition process.

The works in which the bronze powder was made was a marvel of ingenuity, employing only three men (brothers of his wife) and an "engine-driver." It was, in reality, an early example of automation in that each of the machines was designed by Henry himself to be "self-acting." Even the factory building itself was designed to prevent prying eyes from learning anything, and not even his own sons were allowed to enter until they were young men. In this fashion, the secret of the process was preserved for over 40 years.

The process was soon expanded to include different coloured powders, and a "white bronze" was also prepared by barrelling the powder with tin shot under a strong solution of soda carbonate.

When one realizes that after this achievement he went on to take out a large number of patents in the manufacture of glass, in the manufacture of sugar, and in improvements in ordnance, as well as his tremendous work on iron and steel, not to mention dozens of patents in other fields, it can be realized what a tremendous breadth of genius he possessed, and although his fame is as an engineer, there is little doubt that he deserves equal honour as a metallurgist.

Reference

[1] "Sir Henry Bessemer, F.R.S. An Autobiography." 1905. Published by "Engineering."

Research Progress

Strength of Refractories

BY RECORDER

THE testing of metals has advanced to the stage where, by the measurement of a small number of physical and mechanical properties, satisfactorily accurate predictions can be made of the performance of the material under a large number of service conditions. A rather more unhappy state of affairs appears to exist with regard to the testing of refractories. In the first place, the very nature of the conditions to which refractories are usually exposed, e.g. high temperatures, corrosive gases or liquids, makes laboratory simulation difficult. Secondly, refractories are frequently very complex substances constitutionally, and several phase changes and/or chemical reactions may occur before the service temperature is attained, or as a result of thermal cycling or chemical attack during service. This feature also gives rise to manufacturing problems, making it difficult to produce identical batches of nominally the same refractory.

The behaviour of refractories at high temperature has been studied by various methods, one of the most widely used of which is the "refractoriness-under-load" test. In one form of this procedure the refractory is heated at a constant rate under constant load until collapse occurs. In another variation, the test is carried out at constant temperature and load, but as these latter values are usually chosen to cause complete collapse in an hour or two, they resemble stress-rupture rather than creep conditions. It is also improbable that in this type of test, spalling and flaking, common causes of refractory failure in service, will be encountered.

Factors Influencing Failure

The stresses thought to be necessary to promote flaking may arise in several ways, and the influence of various conditions on these stresses has been discussed by W. F. Ford and J. White, of the Department of Refractories Technology, Sheffield University, in a recent Paper.[1] Briefly, stresses can be set up by structural loading, thermal cycling, temperature gradients, anisotropic expansions, and by phase or chemical changes. These variables are not necessarily independent; for instance, thermal cycling may occur over a temperature range that includes a phase transition temperature. This may have been the case in thermal cycling tests carried out by Ford and White on chrome-magnesite bricks.

In their experiments, the temperature cycle was 1 hr. 1,350°C., cool to 1,150°C., 1 hr. 1,150°C., reheat to 1,350°C. After 100 or so of these cycles the chrome-magnesite showed a linear expansion of about 1·8 per cent, and the sonic modulus had dropped from 2·5 to about 0·6 million lb/in^2. Double this number of cycles gave a further expansion to a total of about 2·8 per cent, and the modulus fell to about 0·4 million lb/in^2. A magnesite brick tested under similar conditions showed no change in modulus after 60 cycles, but gave a linear contraction of about 1·3 per cent. The differences between the two types of brick may be in part due to differences in internal stresses prior to testing, as the original modulus of the magnesite brick was nearly five times that of the chrome-magnesite—too large a difference to be accounted for easily as due to composition.

In the tests described above, no load was applied during the cycling of the materials, but in further experiments the bricks were supported on knife edges so that their own weight acted as a load. By measuring the deflections of the samples between the knife edges, the "creep" of the bricks could be followed. It was found that considerable deflections were obtained at quite low loads when the materials were held for moderate periods at 1,350°C. For instance, the chrome-magnesite gave a deflection of about 0·125 cm. when loaded at 2·8 lb/in^2 for about 115 hr.; a similar deflection was also given by a loading of 3·5 lb/in^2, but in a shorter time, namely, 100 hr. Appreciably larger deflections were obtained with the magnesite bricks under generally similar stresses, and a movement of 0·125 cm. occurred after about 60 hr. at 2·0 lb/in^2, or after about 20 hr. at 4·2 lb/in^2.

The "creep" curves so obtained show one or two interesting features, however, which Ford and White do not discuss. For instance, the chrome-magnesite curves are nearly linear, whereas the magnesite bricks gave a typical two-stage creep curve showing an initial period of rapid transient creep. It is possible that at longer times, e.g. of the order of 200 hr., the total deflection given by the magnesite might not be so very different from that given by chrome-magnesite under the same loading. It is also not clear from the details given whether either material underwent volume changes during the experiments, and, if so, whether these changes were allowed for in the results presented.

In further experiments, the time-to-fracture : temperature relationships for magnesite, chrome and two grades of chrome-magnesite bricks were studied. It was found that at a tensile load of 3·3 lb/in^2 immediate fracture occurred in the chrome-magnesite bricks at about 1,550°-1,560°C., depending on the quality, at about 1,310°C. for the chrome bricks, but in excess of 1,700°C. for the magnesite bricks. Failure occurred in about 6 hr. at this load at temperatures of about 1,280°C. (chrome), 1,390°C. (roof - quality chrome-magnesite), 1,430°C. (normal-quality chrome-magnesite), and over 1,600°C. (magnesite). When the applied tensile stress was increased to 6 lb/in^2, however, little difference could be detected between the magnesite and normal-quality chrome-magnesite, immediate failure occurring at 1,610° and 1,550°C. respectively, but delayed failure in 6 hr. occurring at about 1,370°C. for both materials. An interesting aspect of the results was that the "roof-quality" chrome-magnesite bricks fractured in shorter times at a given temperature when loaded at 3·3 lb/in^2 than the "normal-quality" bricks. This might be held to indicate that this type of test does not give information likely to be of direct practical use. Ford and White do suggest, however, that the low tensile and creep strengths of the chrome-magnesite bricks may be the factors influencing flaking of this material as observed in practice.

Bonding Theory

Finally, Ford and White discuss the nature of the bond between the refractory particles. They suggest that at the operating temperature, the particles are held together by the capillary action of liquid lenses at the positions of closest approach (or contact) of the particles. The cohesive force can then be calculated for a simplified model and is found to be directly proportional to the surface tension of the liquid and inversely proportional to the diameter of the solid particles. For magnesite, tentative values may be assigned to the constants of the equation and with a liquid content of 10 per cent, a surface tension of 500 dynes/cm., and an average particle diameter of 0·01 cm., the calculated cohesive strength is about 1·5 lb/in^2. For various reasons, this value is likely to be an underestimate but it is of the observed order of magnitude.

If the views described briefly above are correct, several interesting possibilities arise. First, if the bulk of the material is in the form of discrete, highly refractory particles, the amount of liquid formed at the operating temperature will influence markedly the tensile strength, and if only a very small quantity or none at all is formed,

the strength might be extremely low. The firing process given to such bricks before use can confer strength at lower temperatures only if the bonds formed are not seriously disrupted by the internal stresses generated during cooling after firing. Secondly, the most refractory materials with the minimum of bonding substance may be more prone to failure over a wide temperature range than materials less intrinsically refractory: there is some evidence that this is, in fact, the case. It is clear, however, in many aspects of Ford and White's Paper that much less refined and precise methods are available for the investigation of refractory behaviour than are applied to metals, and the phenomena observed in practice are correspondingly less well understood.

Reference

1 W. F. Ford and J. White; *Trans. Brit. Ceram. Soc.*, 1957, **56** (6), 309.

Rapid Pattern Duplication

ORIGINALLY developed for making tools, jigs, moulds, etc., "Devcon" plastics steel and related materials are now being used for making low cost patterns, core boxes, moulds, and duplicates of wood and metal patterns; and a number of other foundry applications.

Devcon A (80 per cent steel and 20 per cent plastics) is similar to putty and modelling clay in consistency. This is for repair and alteration of wood and metal patterns and core boxes; build-up, repair and alteration of gates; and filling large and small blow-holes in ferrous and non-ferrous castings. It is also used to build up areas in these castings.

Devcon B (80 per cent steel and 20 per cent plastics) is a liquid and can be poured. This material may be used for making patterns, core boxes, models, etc.

Devcon F is an aluminium putty (80 per cent aluminium and 20 per cent plastics), similar to putty or modelling clay in consistency, for filling large or small blow holes and imperfections in aluminium castings, and for building-up and altering aluminium patterns.

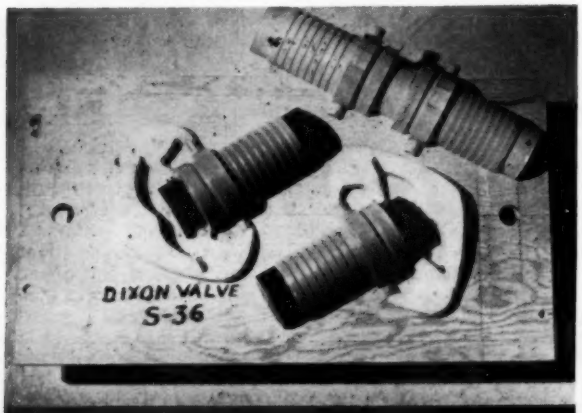
Devcon C is heat-resistant, and this property makes it especially useful for shell moulds or driers.

For the production of duplicate models or a loose pattern, the plaster mould is made in the same way as a sand mould from a loose pattern. In this case, the pattern would be coated with release agent-sealer, and then placed and supported in the box. The plaster is then poured into the box to a point just above the "parting line" of the pattern. When the plaster has hardened, it is scraped down to the "parting line" of the pattern. The pattern is allowed to remain in position and special release agent-sealer is applied over the complete surface of pattern and plaster. More plaster is then mixed and poured to form the top half of the mould. When the plaster has hardened, the mould halves should be separated and the pattern removed. The resulting cavity should be coated with the special release agent-sealer. Risers and vents should be provided, as would be done in making a sand mould for a metal casting. Moulds should now be assembled. The cavity is now ready to receive the Devcon B, which is poured in slowly, entrapment of air being avoided. After hardening (approx. 2 hr.), the plaster mould may be removed, vents and risers are removed from the pattern and smoothed off flush with the surface.

Further materials have recently been added to the range, including the following:—

Devcon WR is a wear-resistant self-lubricating material for making machine parts and for building up surfaces subject to severe wear. It may also be used for duplicating masters and for facing forming dies.

Devcon Flex is an accessory for making Devcon A, B, F and WR more flexible or rubber-like, and Devcon Thinner promotes more fluid mixtures of these materials.



Example of the accurate duplication of pattern detail when reproducing from original wood patterns with Devcon B. Devcon products are marketed in this country by E. P. Barrus (Concessionaires) Ltd., 12-16 Brunel Road, Acton, London, W.3.

Set of aluminium core boxes in which the thin wall section of the underside did not allow sufficient room for the firm placing of guide pins. Three corners of the underside of the box were built up with Devcon and drilled for guide pin holes.

Hot Tinning

DEVOTED principally to practical techniques of hot-tinning, the Seventh Annual Tin Conference, organized by the Centre d'Information de l'Etain, in Paris, was held recently.

In an introductory review, Dr. W. E. Hoare, assistant director of the Tin Research Institute, Greenford, Middlesex, underlined the effectiveness of the old-established technique of hot-tinning and the good possibilities of fitting the process into the technique of modern industry.

A new method of hot-tinning cast-iron, the Direct Chloride Process, recently evolved in the laboratories of the Institute, calls for no equipment and could be operated with the normal equipment available in a hot-tinning workshop. The preparation before tinning requires carefully controlled blasting with fine steel grit and dipping in a flux solution, not dissimilar from the flux used in ordinary tinning processes.

A film on hot-tinning, made at the laboratories of the Tin Research Institute, was shown, and other topics dealt with mechanization of hot-tinning of a variety of different articles.

New Plant & Equipment

Oven Processing

A RANGE of small and medium size standard, general-purpose electrically - heated industrial tray loading ovens, with alternative types to cover all industrial applications, such as baking, curing, drying, polymerizing, stoving, etc., has been introduced by Barlow Whitney Ltd., 2 Dorset Square, London, N.W.1.

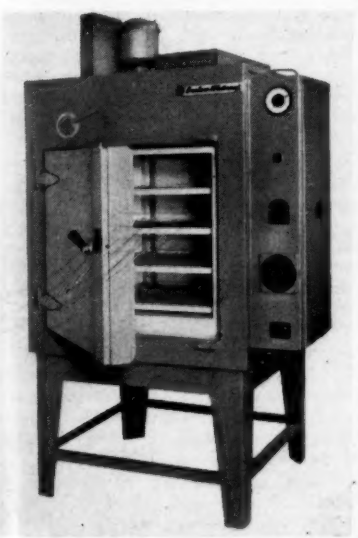
There are two basic types in the new standard range, designated as Series E.150 and E.300, which cover operating temperatures to 150°C. and 300°C. respectively. Internal capacities are from 1 to 72 ft³, and the majority of sizes are available with natural or fan circulation.

Series E.150 ovens are of robust all-steel double-skin construction, the cavity walls and door being fitted with high-grade non-sag pads, ensuring excellent insulation against heat losses.

The heating elements are totally-enclosed, metal cased type, operating at black heat. They are housed in the base or side walls behind anti-radiation shields. Close temperature regulation is effected by an adjustable hydraulic thermostat, with separate neon indicator.

Series E.300 ovens for temperatures to 300°C. are of somewhat heavier construction and more heavily insulated for dealing with higher temperatures. Although available with natural ventilation, the types chiefly in demand by industrial users are those fitted with full forced circulation with either horizontal air flow (H.A.F.) or vertical air flow (V.A.F.), the choice being determined by the nature of the work to be processed.

The B-W type E300/222 H.A.F. electric oven with horizontal air circulation



Both systems incorporate a powerful motor-driven fan, housed in the roof, providing up to 10 changes per minute, thus ensuring uniform temperature conditions and rapid heat transfer. The air flow is adjustable from full throughput of fresh air to partial or total recirculation, as requirements dictate.

The temperature is automatically controlled within close limits by means of a 4 in. dial indicator-regulator. Additionally, these models are provided with a safety thermostat to limit the temperature and protect both the charge and the heating elements should the main controller fail to function.

Recorders, programme controllers and process timers, and other optional features can be provided to suit any specific requirements.

Induction Heating

SPECIALLY designed for silicon refining and similar processes where a very high work coil kVA is essential, a 6 kW induction generator, the Radyne Model C50/SR, has been introduced by Radio Heaters Ltd., Eastheath Avenue, Wokingham, Berks.

This induction equipment operates at a nominal frequency of 5 megacycles/sec. and will develop a peak voltage in excess of 4,500 V across a work coil of 0·5 microhenries. By using a higher frequency than is normal for induction heating, it is possible to achieve a high work coil kVA without using a generator of high power. The relative efficiency of the process is, therefore, high and the capital cost low.

The equipment is designed for use with work coils of between 0·3 and 1·0 microhenries. As the work coil forms the actual tank coil of the oscillator, the operating frequency will vary over a range of 3·5 to 6·5 megacycles.

A manual power output control is provided in the form of a separate self-contained voltage regulator. This feeds the primary of the high voltage transformer and provides the facility of varying the anode voltage fed to the oscillator valve down to 25 per cent of the normal value of 5·5 kV D.C. This regulator can also maintain, if desired, a constant output at any predetermined voltage setting over its control range.

An additional facility can be provided if required whereby the output of the generator is reduced almost instantaneously from 6 to 1 kW. This is achieved by initially by-passing the voltage regulator and then by a contactor sequence switching in the regulator, which has previously been set for reduced voltage. This facility is most useful for initiating the process cycle when silicon refining. Provided the silicon rod to be processed is not of a high purity it will be possible to heat the rod from cold without the necessity for pre-heating by conduction or other methods. Once the rod commences to heat, however, its resistance decreases rapidly, which results in an accompanying sudden increase in temperature rise. By the depression of a push button the voltage regulator can be switched into circuit, thereby instantaneously reducing the power input to the silicon to a predetermined value to match the change in the characteristics of the material and the traverse speed for refining.

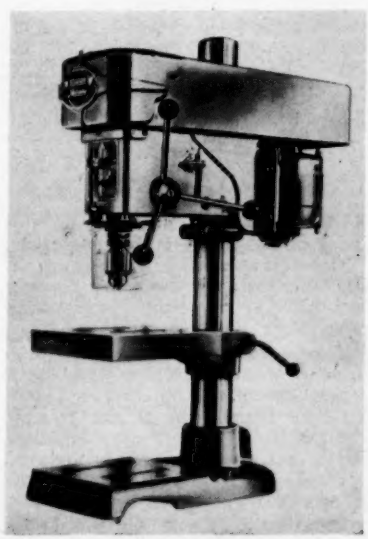
Drilling

AN improved design of single spindle drilling machine, available as a bench or floor model, has been introduced by Startrite Engineering Co. Ltd., Waterside Works, Gads Hill, Gillingham, Kent. Known as the Startrite Mercury, its sturdy construction, balanced pulleys, six-splined spindle drive with four journal ball bearings and ball thrust collar at spindle nose ensure long, accurate service.

The head unit is adjustably mounted and may be swung to any position around the column. It carries the spindle unit, driving pulleys and motor power unit.

The spindle is supported in a ground cast iron quill, carrying one ball thrust race and two ball journal bearings, with drive through broached bronze sleeve. Spindle pulley is independently mounted on two ball bearings absorbing all thrust from belt transmission.

Bench model of the Startrite Mercury single spindle drilling machine



Enclosed spiral tension springs are fitted for quill return, and the head clamping gear is of compensating type.

The drive is taken from a vertically mounted motor through a totally enclosed V-belt and four step pulleys. The motor platform is slide mounted, and a heavy type rotary starter is fitted. The table is a one-piece type with a large working area.

X-Ray Viewing

DESIGNED primarily for the examination of industrial radiographs with a wide range of densities, an "Industrex" Illuminator, Model 2, has been introduced by Kodak Ltd., Kingsway, London, W.C.2.

The light-source consists of six 15-watt "colour matching" fluorescent tubes, giving even illumination of "daylight" quality over the whole area of the screen. This light allows for critical examination of radiographs with densities over 3·5 by full room illumination. Despite the intensity of the illumination, it is completely cool in operation, so that the usual ventilation holes are not necessary, and consequently the illuminator does not collect dust through convection. Because of this absence of heat, the illuminator can be "angled" or let into a bench if required, even in a horizontal position.

A masking device cuts out unwanted light from the viewing screen and operates from 14 in × 17 in. down to about 2 in × 2 in. The plastics opal viewing screen is robust and can be easily removed for cleaning.

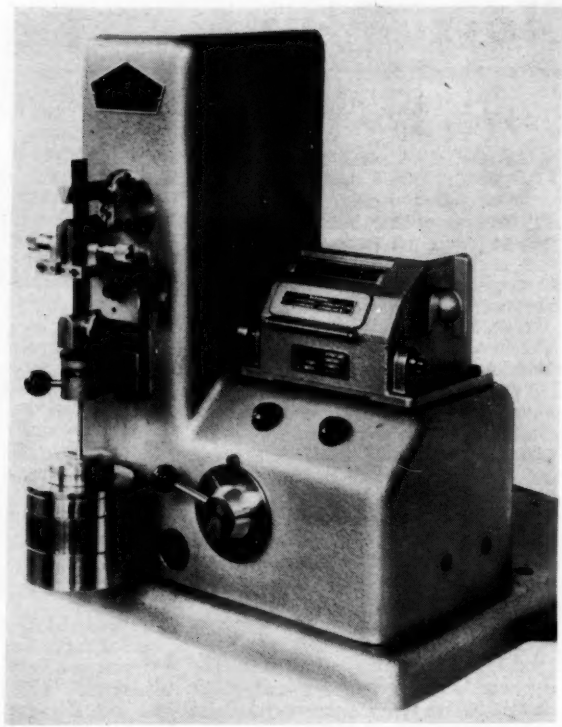
Two studs are fitted above the diffusing screen to take the "Kodak" Wet Film Attachment, or to hold hangers containing wet radiographs. Dry radiographs are held in position by spring-loaded metal balls located in a metal channel immediately above the illuminated area.

The Kodak "Industrex" Illuminator Model 2 can be used on 50-cycle A.C. supplies only, within the range of 200-250 V. Illuminators for use on 110 V A.C. circuits can be supplied to special order.

Bend Testing

DEVELOPED for carrying out bending tests on sheet materials, such as metal foil, thin gauge tin and other materials, a machine recently introduced to this country incorporates many basic improvements.

The apparatus is equipped with a drive which can be steplessly regulated, and which allows the carrying out of bending alternations at the rate of 110-1,000/min. Adjustment takes place conveniently by means of a hand-wheel with associated scale arranged on the front side of the apparatus.



The bend testing machine for thin materials made by Karl Frank G.m.b.H.

The bending-angle which the test piece can attain on both sides is adjustable within the region of 0-90° at choice. The head, which carries the precision made bending-edges, remains stationary, and the upper clamp describes an arc through a distance of 1 cm. about these edges.

The bending edges can be adjusted by means of two micrometer screws, to be located exactly on the axis of bending. Simultaneously, these micrometer screws serve for fixing the test line along which the bending-test is to take place. In order to bend accurately different strength test pieces exactly along the neutral axis, the head, which carries the bending-edges, is also adjustable vertically, and can be set by means of a vernier scale to an accuracy of 0·1 mm.

The preloading of the test piece takes place by means of a suspension-weight arranged on the lower clamp. It is possible to select a load of 100-5,000 gm., rising in 100 gm. steps. On breakage of the test piece, the loading weight falls and switches the machine off automatically. A built-in counter records the number of bending operations, at the end of which the apparatus switches itself off automatically without test piece breakage. The clamp width amounts to 32 mm. Control of the drive motor takes place by means of a switch-guard built into the apparatus, so that, by means of press-buttons marked "on" and "off," operation of the apparatus is made extremely simple.

The manufacturers are Karl Frank G.m.b.H., Weinheim an der Bergstrasse, Western Germany, and the apparatus is marketed in Great Britain by H. E. Messmer Ltd., 12 Bateman Buildings, Soho Square, London, W.1.

Air Blowing

RECENTLY added to the range of Holmes-Connersville positive air blowers is a 12 in. machine which features a redesigned "H" type casing. Two impellers, rotating in opposite directions and mounted on parallel shafts, are used. The form and machined finish of these impellers is such that, during rotation, a small accurate clearance is maintained between them, and between the impellers and the casing. Wide-faced spur gears are used to maintain these clearances. The gears are keyed to the shafts, one gear having a special key for setting the impeller clearances. The lower part of the gear case is divided into a gear section and a sump section, thus allowing a greater volume of oil to be in circulation. Adequate cooling ribs are provided on machines working at high pressures. Standard roller bearings are mounted in bearing carriers for easy removal.

The range of blowers covers a low pressure range, with capacities from 910 to 1,844 ft^3/min., a medium pressure range, with capacities from 1,440 to 3,100 ft^3/min., and a high pressure range, with capacities ranging from 270 ft^3/min. to 1,235 ft^3/min.

These blowers are a product of W. C. Holmes and Co. Ltd., Turnbridge, Huddersfield.

Industrial News *Home and Overseas*

Graduate Course in Foundry Science

At present Great Britain is the only leading industrial country without comprehensive university training in metal founding. It is, therefore, interesting to note that the Department of Industrial Metallurgy of the **University of Birmingham** now proposes to establish a graduate course dealing specifically with foundry science and engineering. This course will not compete with the course given at the National Foundry College at Wolverhampton, rather its aim and scope will be complementary to those of the Foundry College.

The course will be of nine months' duration, leading to a Diploma in graduate studies, or one year's duration, leading to a M.Sc. degree. The present plans are to hold this course every two or three years. During the intervening years similar graduate courses will be held in other fields of industrial metallurgy.

The basic idea underlying the planning of this course is that it should provide post-graduate training in which the fields of foundry science and foundry technology are carefully balanced. Students will also have the advantage of close contact with research teams active in the field of melting and casting of metals.

Copies of the syllabus and full details of the course generally may be obtained from the Registrar, The University, Edgbaston, Birmingham, 15, or from the Department of Metallurgy at the University.

Wilmot Breeden Fellowships

An announcement has been made by **Wilmot Breeden Ltd.** that it proposes to sponsor two Fellowships, each worth £1,000 per annum, one at the University of Birmingham and the other at the College of Technology, Birmingham. An unusual feature of these Fellowships is that the successful candidates will divide their time between the University or College and the company.

The terms of the Fellowship awards are so arranged that at any one time there will be a Wilmot Breeden Fellow working in association with the University and another with the College. These Fellowships will be advertised every year in March, in "odd" years in association with the University and in "even" years in association with the College. Each Fellowship will normally be held for a period of two years. A candidate for a Fellowship should normally have had two or three years' research or industrial experience. He must be acceptable to the academic authority and would be expected to have an honours degree in a University in the British Commonwealth, a Diploma in Technology, or an equivalent qualification. An application for a Fellowship should outline a two-year investigation or project on which the candidate seeks to work.

Full details and applications for these Fellowships should be addressed to the Secretary, Wilmot Breeden (Holdings) Ltd., Amington Road, Birmingham, 25.

Vacuum Furnaces

Less than 12 months after receiving Treasury approval to the Agreement under which **Wild-Barfield Electric Furnaces Ltd.** are manufacturing vacuum arc, induction and resistance furnaces and vacuum analysers to the designs of National Research Corporation, Massachusetts, U.S.A., the vacuum division of the British company reports very satisfactory progress.

There are in hand, the company states, a considerable number of vacuum furnaces, including, it is said, the largest induction heated equipment in the country, and other units for melting and casting beryllium and uranium. In addition, numerous orders are in hand covering vacuum gas analysis equipment. In order to ensure that such orders may be proceeded with expeditiously, a completely new designs and production department has been created in respect of vacuum equipment. This department operates in close liaison with its American counterpart and thus receives first-class advice concerning all aspects of vacuum furnace manufacture.

Welding Supervision

Part of the Government's nation-wide road improvement scheme is the Higher Walton Bridge, on the Preston (Lancs.) new motorway, which spans the river Darwen and the main (A675) Preston-Blackburn road. Weighing over 600 tons, this prefabricated bridge, made at the works of Dorman Long (Bridge and Engineering) Ltd., is being taken to the site in sections for final erection and welding.

In view of the importance of this bridge, and especially the more highly stressed site welds, **Welding Supervision Ltd.** have been engaged to control all phases of site welding.

A Birmingham Event

It has been announced by the **Birmingham Metallurgical Society** that the annual dinner of the society will be held this year on March 27 next, at the Imperial Hotel, Temple Street, Birmingham, at 7 p.m. Tickets for this event, price 27s. 6d., may be obtained on application to the secretary of the society, c/o Brown Bayley Steels Ltd., 21 Bennetts Hill, Birmingham, 2.

New Branch Office

A new branch office has been opened by **Martonair Ltd.** at 71 Carver Street, Sheffield. This branch will carry stocks of pneumatic cylinders, valves and accessories.

Annual General Meeting

Early notice is given by the **Association of Bronze and Brass Founders** that the annual general meeting of the association will be held on Wednesday, April 30 next, at the Connaught Rooms, Great Queen Street, London, W.C.2, commencing at 10.30 a.m.

New Factory

Plans for the erection of a new factory at Treforest, Glam., to house **Firth Cleveland Instruments Ltd.,** newly formed last May as a subsidiary of Simmonds Aerocessories Ltd. are now completed. This new factory will be a building of approximately 350 ft. long and 240 ft. wide, and will cover an area of some 80,000 ft^2, with first floor office accommodation on two sides.

The factory will be bounded on its east side by the main trunk road from Cardiff to Pontypridd, and will be joined to the main Simmonds factory by an overhead canopy to facilitate the transfer of goods and components in inclement weather. When completed this factory will enable the company, now marketing the instruments produced by the Simmonds company, to also take over production of new products in the general instrumentation field for aircraft, marine, nuclear and industrial uses.

Institute of Metals

It has been necessary for the **London Local Section** of the Institute to change the date of its annual general meeting, which will now be held on Thursday, April 10. At the close of this meeting the Section will be addressed by Mr. W. E. Ballard on "New Protective Coatings for Metals."

An informal dinner of the section has been arranged to take place on Tuesday, March 25 next, at the Horseshoe Hotel, Tottenham Court Road, London, W.1, at 6.30 p.m. Principal guests at this function will be Professor J. G. Ball and Mr. H. W. G. Hignett.

Geneva Atom Conference

A second International Conference on the Peaceful Uses of Atomic Energy is to be held in Geneva this year from September 1 to 13. The provisional agenda agreed by the seven-nation Advisory Committee covers all aspects of the subject. As in 1955, two atomic energy exhibitions will be held during the conference. The first of these will be a scientific exhibition under the auspices of the United Nations and the other will be a commercial exhibition.

Davy and United

As from Monday last (March 10), all the Sheffield activities of **Davy and United Engineering Co. Ltd.** will be concentrated at Darnall Works, Sheffield, 9, which thus becomes the head office of the company. Davy-United have, therefore, now disposed of Park Iron Works in Sheffield, which they had occupied continuously since 1851, twenty-one years after the original founding of the company.

Darnall Works was first established in 1921 and has been systematically developed ever since, culminating in the recent building of a new headquarters block housing all engineering and administrative departments.

A New Exhibition

Britain's first **Chemical and Petroleum Engineering Exhibition,** sponsored by the British Chemical Plant Manufacturers' Association and the Council of British Manufacturers of Petroleum Equipment, is being held at Olympia, London, from June 18-28, 1958, and its importance and scope are already clearly determined. No fewer than 250 exhibitor manufacturers have booked stands, and their exhibits already amount to 125,000 ft^2—occupying the whole of Olympia's two largest halls and galleries.

Proof of the tremendous development of these industries in Britain, and of the

wide scope of the exhibition, is the fact that plant, equipment and ancillary services offered by the exhibitors will cover nearly 1,000 product classifications. During the exhibition, The Institution of Chemical Engineers, in conjunction with The Institute of Petroleum, will stage a Symposium on "The Organisation of Chemical Engineering Projects," and Papers will be presented at four sessions spread over three days. This Symposium will also form part of the 1958 programme of the European Federation of Chemical Engineering. There will also be film shows which will demonstrate the valuable contribution which has been made by British chemical and petroleum engineering firms to the growth of the industries which they serve.

Metal Finishing

Branch meetings of the **Institute of Metal Finishing** will be held next week as follows:—The London section will meet at the Northampton Polytechnic at 6.15 p.m. on Monday, March 17, to hear a Paper by Mr. H. Cann on "Anodes."

The South-west branch will meet on Tuesday, March 18, and will pay a works visit to Rotor Ltd., at Gloucester. After this visit a meeting will be held at the Spread Eagle Hotel, at 6.30 p.m., when Mr. A. F. Brockington will give an address on "Nickel Plating Techniques."

Copper in Poland

Prospecting work under the direction of the Institute of Geology in the Wroclaw province of Poland has recently led to the discovery near Lubin of deposits of copper ore extending under an area of about 22 by 6 km., at a depth of about 600 m. The average copper content of the ore is 1·4 per cent, so the new deposit is richer than the ore beds at present industrially exploited in Poland. The seam is about 225 cm. thick, and the yield of pure metal per sq. metre of ore, in samples taken from bore holes at Lubin and Sieroszowice is 95·64 and 85·04 kg. respectively.

The ore contains some quantity of zinc, lead, silver, and vanadium, and small amounts of cobalt and molybdenum. Problems of extraction methods are now under discussion, though it is evident that industrial exploitation cannot begin for some years. Prospecting began in the region as early as 1955, but the initial borings only went to 400 m. and yielded no result, and it was not till deeper borings by the Central Petroleum Board revealed the existence of the Cechsztyn formation usually associated in Europe with the presence of copper ore (c.f. the Mansfeld basin in Germany) that real evidence was afforded for the existence of copper in the area.

Welding News

A new 180-page Welding Data Book, describing simplified welding procedures for application to all metals at reduced temperatures, has recently been introduced by **Eutectic Welding Alloys Co. Ltd.** This pocket-sized book is a useful guide to improved welding techniques with torch and electric arc, and contains information on maintenance, repair, salvage and fabrication with all metals. Procedures are described for obtaining maximum machinability in work-time and costs, with superior weld quality.

A large number of applications for welding in every industry is given, including joints requiring special properties, such as high electrical conductivity, resistance to corrosion, and suitability for tinning and coating. Welding procedures which save dismantling and eliminate pre- and post-heating are also treated. A full, practical discussion on Eutectic's low heat input metal-joining process, pointing out its great flexibility and easy application, is also included in this book.

Aluminium in Australia

It is learned from Brisbane that negotiations between Commonwealth Aluminium Proprietary Ltd. and the two companies on the Blair Athol Coalfield Ltd. centred in the granting by the two concerns of an option on their mining leases. These negotiations have now been completed, but the granting of the option is subject to confirmation by shareholders of the two mining companies. The purpose of the option is to enable Commonwealth Aluminium to investigate, over a period of five years, the possibility of using the Blair Athol coal to fuel a power station supplying current to an aluminium smelter located on the Queensland coast, which is about 130 miles from the field.

Paint Manufacture

Featured at the Oil and Colour Chemists' Association Technical Exhibition in London this week was an interesting exhibit contributed by **British Titan Products Ltd.** This exhibit indicated the extent to which the titanium pigment content of paints may be increased to obtain the best results. The exhibit was confined to air drying systems of gloss, undercoat and flat wall paints.

The possibility of obtaining one coat "hiding" with white gloss paints over undercoats of varying colour and reflectance was examined with respect to pigment content. In gloss paints, also, the effect was demonstrated of making pastel shaded paints with increasing amounts of titanium oxide. Rutile and anatase pigments were compared for hiding power at equal pigment/binder ratio and at equal cost.

Long Service Awards

With a total of 896 years' service between them, 28 employees of the Birmingham firm of **H. W. Carter and James Ltd.** were presented with gold watches at a dinner given in Birmingham on Monday last. One employee had 50 years' service to his credit and none of the others had less than 22 years.

The presentations were made by the joint managing directors of the company —Mr. G. J. Price and Mr. A. E. Whitmarsh. These two gentlemen also were presented with watches as they had 34 and 40 years' service each respectively. The dinner, which was followed by a dance, was attended by over 150 employees and guests.

Ingot Milling Machine

Complete electrical equipment for a large ingot milling machine manufactured by W. H. A. Robertson and Co. Ltd. has been supplied by **The English Electric Co. Ltd.** This rolling machine has been ordered by the American Brass Company for its plant at Terre Haute, Indiana, U.S.A.

The machine will be used for milling the faces of aluminium and alloy ingots up to a size of 60 in. wide by 12 in. high by 120 in. long, and will remove imperfections from the cast ingots before they are rolled into strip and subsequently into foil.

Electrical equipment includes a 200 h.p. D.C. motor driving the milling cutter and a 6 h.p. D.C. motor driving the ingot carriage, both supplied from a Ward-Leonard generator set driven by a 265 h.p. A.C. motor. The cutter can be run at any desired speed from 2,000 to 4,000 ft/min. Ingot carriage forward speed is variable with a fast return speed, the cycle of operation being completely automatic. Control and operation of these drives is by push-buttons and control switches on a desk adjacent to the milling machine. A contactor panel and various auxiliary drives were also supplied.

Selling to Canada

News from **Enfield Cables Ltd.** is to the effect that they have signed an agreement with Federal Wire and Cable Division, H. K. Porter Company (Canada) Ltd. whereby that organization will market Enfield products in Canada. The agreement also provides for the sharing of technical "know-how" and experience should the Canadian company decide to embark on the manufacture of power cables in the future.

Enfield's resident engineer in Canada, Mr. J. Morgan-Blades, will remain in his present position and will act as technical adviser to Federal on power cable matters.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week totalled 17,379 tons, comprising London 5,852, Liverpool 10,517, and Hull 1,010 tons. Copper stocks totalled 19,972 tons and comprised London 11,474, Liverpool 6,858, Birmingham 965, Manchester nil, Swansea 425 and Hull 250 tons.

Russian Tin and L.M.E.

In announcing that the former Russian tin brand "HO3" has been registered on the London Metal Exchange under the new brand mark "XXX," the Committee of the L.M.E. states that brand "XXX" has been registered under Class A1 of the standard contract in substitution of "HO3" brand, and such brand will constitute a good delivery on and after March 10, 1958.

New Headquarters

New offices have been taken over by the **United Kingdom Atomic Energy Authority** at 11 Charles II Street, London, S.W.1, with the telephone number of Whitehall 6262.

Open Days

It is announced by the Department of Scientific and Industrial Research that the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, is to hold "Open Days" on Wednesday and Thursday, June 4 and 5 next. The whole of the laboratory will be open for inspection, including two new laboratories for research on mechanism and engineering metrology and for research on heat-treatment.

Representatives of any organization with engineering interests will be welcome, and applications for invitations, stating which day is preferred, should be sent to the director.

New Trade Mark

We learn from **Firth Cleveland Steel Strip Ltd.** that the trade mark "Fircleve" has been accepted by the Registrar of Trade Marks as applicable to the range

of cold rolled steel strip and flattened wire, and cold rolled hardened and tempered steel strip and flattened wire, produced and marketed by the company. The trade mark registration number is 770,885.

Subsidiary Changes Name

Coincident with the announcement that the Canadian subsidiary of **George Kent Ltd.** has been awarded the contract for the instrumentation of units 1 and 2 for the Boundary Dam Thermal Generating Station at Saskatchewan, we are informed that the name of this subsidiary company, previously Kent-Norlantic Ltd., has been changed to George Kent (Canada) Ltd.

Corrosion of Boiler Tubes

A joint meeting of the Corrosion Group and the Manchester Section of the **Society of Chemical Industry** will be held in the Robinson Lecture Theatre, The University, Manchester, on Friday, March 28, at 6.30 p.m., when a Paper on "Recent Research on the Corrosion of Boiler Tubes" will be presented by Dr. E. C. Potter, Ph.D., D.I.C., F.R.I.C.

News from Birmingham

Conditions have altered little in the Midland metal industries. There is a seasonal recession in the building trade, and the wintry conditions have hampered outdoor work. One firm in the edge tool trade has introduced short-time working because of a shortage of orders, which, they say, is due to a certain extent to seasonal recession. They are also, however, finding it more difficult to compete in overseas markets because of the high prices of their products compared with foreign competitors. This apart, the general picture of trade is one of quiet confidence. The motor trade maintains its heavy demand for metals, and electrical equipment firms have booked further substantial contracts for power stations in this country and abroad.

Re-rolling firms in the steel trade are short of orders, and one establishment has started a four-day week. Sheet makers are fully employed, and deliveries of structural steel to building sites are substantial. Stocks of both pig iron and semi-finished steel are higher as compared with a few months ago. Demand for builders' iron castings has dropped appreciably, but there is still a strong call for castings for the motor trade. Steel is being used extensively in the building of rolling stock and in the provision of coal mining machinery.

Tin Council Meeting

Chairman of the International Tin Council, M. Georges Peter stated in London last week that the Council would consider export control of tin for the third quarter of this year when it meets again on April 29. Speaking at a press conference following the meeting of the Council, he said: "I am sure the matter will be considered again when we meet in April. That does not mean that there will be a change in the quota, but there will be a discussion." He added that the quota for the third quarter of this year had not been discussed at the meeting because it was too early to take a decision so far ahead. M. Peter promised that the exact amount of metal in the buffer stock at the end of November would be made public after the next meeting of the Council.

The buffer stock stood at 4,315 tons at the end of September last. Although no later figures were announced, M. Peter agreed that at the end of November the buffer stock stood at least at 10,000 tons (second contribution), and by the end of December at least at 15,000 tons (third contribution) He could give no details about the special fund which representatives of the six producing countries agreed in January to recommend their Governments to set up. It is so far known only that Malaya has approved of this fund. M. Peter refused to give any information about the reaction of the other Governments. The fund, he said, had been suggested to give the buffer stock manager an alternative method of purchasing tin if the need arose.

Questioned about tin from Russia, Mr. W. Fox, secretary of the Council, said that exports from Russia during 1957 as a whole were estimated at 9,300 tons. "This is a correct estimate to within 100 or 200 tons," he said. The surplus of tin had again been reviewed at the meeting, but no announcement could be made, said Mr. Fox, except that it was slightly less than the estimate of 12,500 tons arrived at last September.

Shipments of tin from Thailand during January had been 750 tons, compared with 1,400 tons in December. This compared with general export figures of the other countries, which were expected to have exported more than one-third of the fixed quota for the quarter during January, about one-third during February and less than one-third during March.

Swiss Aluminium

Under the name of Kaiser Aluminium A.G., a new company has been constituted in Switzerland. The initial capital is 100,000 Swiss francs. Declared aims of the new concern are to give technical and commercial advice on the manufacture and trade in aluminium and aluminium products, in Europe and in Africa. It will also trade in aluminium, aluminium products, and materials and chemicals used in the aluminium industry in Switzerland and other countries. The chairman of the board of the new concern is an American citizen, Mr. Raymond G. Boyd, of San Francisco.

Orders from Russia

Rumours that Russia might place orders for copper wire in Britain (35,000 to 40,000 tons have been mentioned) have recently caused some speculative buying and covering on the London Metal Exchange in anticipation of improved outlook. Russian buying of copper wire in Western Europe is nothing new, for substantial quantities have been shipped ever since restrictions were lifted late in 1954. Last year some 48,000 tons were exported from the U.K. to Russia, Czechoslovakia, Poland, etc., and 52,000 tons the year before. Indeed, but for these orders the trend of U.K. copper consumption might have given a very different picture. On top of this, other Western European countries are understood to have exported between 20,000 and 30,000 tons each year. The delay in placing 1958 contracts with British wire mills may be cause for concern. Orders of 6,300 tons have already been given to Chilean manufacturers and negotiations continue regarding terms of up to 50,000 tons; though there is some doubt as to whether sufficient capacity is available in Chile.

Orders of up to 50,000 tons placed now in Britain would do no more than maintain the *status quo* of recent years. Any lower quantities would mean British wire mills being that much worse off.

Parliamentary News

By Our Lobby Correspondent

Metal Corrosion.—At Question Time in the Commons, Mr. R. W. Elliott asked the Parliamentary Secretary to the Ministry of Works, as representing the Lord President of the Council, what major advances the Chemical Research Laboratory had made in research to reduce wastage caused by metallic corrosion.

The Parliamentary Secretary to the Ministry of Works, Mr. Harmar Nicholls, replied that the Chemical Research Laboratory of the Department of Scientific and Industrial Research had discovered corrosion inhibitors for metals in storage and in transit, and also in engine cooling systems such as motor car radiators. The Laboratory had also developed methods of preventing premature failure of tubes in marine boilers.

Automation.—Mr. John C. Jennings asked what contributions were being made by the Department of Scientific and Industrial Research towards the development to automation with the object of increasing industrial productivity and commercial efficiency.

Mr. Nicholls replied that the National Physical Laboratory of the D.S.I.R. had done pioneer work in developing basic computing principles for high-speed digital computing, especially for mechanizing clerical work. The Laboratory was now turning its attention to the automatic control of the flow of work in factories. Completely new principles for the automatic control of machine tools and for process control in the oil industry were being investigated.

Forthcoming Meetings

March 17 — Institution of Production Engineers. Stoke-on-Trent Section. The Grand Hotel, Hanley, Stoke-on-Trent. Annual General Meeting, followed by "Powder Metallurgy." P. R. Marshall. 7 p.m.

March 17—Institute of Metal Finishing. London Branch. Northampton Polytechnic, St. John Street, London, E.C.1. "Anodes." H. Cann. 6.15 p.m.

March 18—Institute of Metal Finishing. South-West Branch. Spread Eagle Hotel, Gloucester. "Nickel Plating Techniques." A. F. Brockington. 6.30 p.m.

March 18—Institute of British Foundrymen. East Anglian Section. Lecture Hall, Public Library, Ipswich. "Experiences of Forty Years in and around Foundries." W. Hardy. 7.30 p.m.

March 18—Institute of British Foundrymen. Slough Section. Lecture Theatre, High Duty Alloys Limited, Slough. Annual General Meeting, followed by a Paper on "Non-Destructive Testing of Castings." S. L. Fry. 7.30 p.m.

March 19—Institute of Metals. Powder Metallurgy Joint Group. Church House, Great Smith Street, London, S.W.1. All-day Meeting. Informal Discussion on "Developments in the Practice of Compacting and Sintering." 10.30 a.m.

March 20 — Southampton Metallurgical Society. The University, Southampton. "Stress Corrosion." K. Wilson. 7.15 p.m.

Metal Market News

A MUCH more cheerful tone was in evidence on the Metal Exchange last week, although optimism was rather dashed by the collapse of copper on Friday, when the close in the afternoon was £4 below the highest point reached on the midday session. Day after day Wall Street made a good showing, and there was a complete absence of the somewhat panicky atmosphere which had characterized that market of late. The London Stock Market also put up a much better show, but the chief factor was the better report of conditions in the United States, where it seemed as though the decline in activity in steel had reached its nadir. At the same time, there is really no indication that a return to brisk trading is just round the corner and, indeed, according to one authority "the world is moving into a position of abundance, smaller profit margins and fierce trade competition." This question of over-supply is certainly true of copper, for there is really very little evidence that the production cuts so far instituted have been effective in putting the statistical position to rights. The February copper figures are awaited with interest and they should be available next week. On the question of cost of production opinions differ, but it seems likely that at a price level ranging between £170 and £180 a very large tonnage of copper can be produced at a profit.

The turnover on the standard copper market last week was the largest for a long time past, certainly since Christmas, for it amounted to 12,425 tons, without Kerb dealings, which were probably not inconsiderable. The highest settlement price was £167 and on Friday last, during early trading on the midday session, £170 was paid for the three months' position. After this, however, the market fell off rather rapidly and in the afternoon session the downward thrust was still in evidence, so that at the close cash was no better than £163 10s. 0d., while three months stood at £165 10s. 0d. On balance, therefore, there was a nett gain of £3 in cash and of £3 10s. 0d. in three months, the contango widening to £2 from 30s. a week earlier. No change was made in the American quotations, which remained at 23 cents for the custom smelters and 25 cents for the producers. Two increases in the Belgian price were seen during the week, one of 50 points and the other of 25 points, bringing the quotation up to 23½ francs per kilo. Stocks of copper in Metal Exchange warehouses advanced to 20,057 tons, an increase of 202 tons. According to report, the firmness of the market last week was due to covering against Russian orders for copper wire. Last week's rally on the London market would seem to make it fairly certain that the U.S. producers will not cut their 25 cents price, and in that case there is unlikely to be any question of an import duty on copper in the U.S.A. before July 1.

So far as tin was concerned, the week opened with news of an increase in warehouse stocks of 579 tons to 17,985 tons, so that reserves of tin, largely held by the Tin Council, are now approaching the copper total. The turnover last week in Whittington Avenue amounted to 1,410 tons, and on balance cash put on £4 10s. 0d. and three months £6 10s. 0d., the contango widening to £7. Bull operators were encouraged by the report issued after the meeting of the Tin Council to the effect that export quotas would not be changed. Both lead and zinc showed an improved tone, lead improving to the extent of 25s. for March and 15s. for June, the backwardation widening to 15s. In zinc, March put on £1 12s. 6d. while June closed £1 better at £63 10s. 0d., a small contango of 2s. 6d. ruling on Friday afternoon last. Both zinc and lead are still suffering from uncertainties about the adjustment of the tariff in the United States.

New York

Custom smelters sold a fair amount of electrolytic copper at 23 cents a lb. during the early part of last week. The price spread of two cents between the producer price and the custom smelter price encouraged independent fabricator buying of the cheaper-priced custom smelter electrolytic. One leading producer source said that whereas custom smelters normally sold about 10 per cent of the total U.S. copper sales volume, they were currently garnering about a 50 per cent share of the market. This reflected their lower price and the generally depressed state of copper sales, he said.

However, custom smelters' sales turned quieter later in the week, as some fabricators went to dealers for copper at about half-a-cent a lb. under the custom smelter price. The producer price at 25 cents was definitely weak, but leading sources said various problems were facing producers at a lower price. First, Phelps Dodge was co-operating with smaller domestic producers in a fight for higher domestic copper tariffs, and if the price was reduced below 25 cents this might tend to undermine the struggle for higher tariffs. Secondly, Kennecott and Anaconda, whose Chilean subsidiaries were the leading producers in Chile, were hesitant to initiate a price cut here because it would bring into motion the machinery for a two cent copper tariff. Because of their foreign copper production they were reluctant to face a copper tariff, the sources said. Copper cutbacks and closedowns continued. Howe Sound Mining Company's Britannia property in British Columbia closed down at the beginning of March, and Miami Copper Company announced that, effective April 1, it was suspending operations in the lower grade ore sections of its Miami Ariz underground mine. The Howe Sound Britannia mine closing will mean a loss of from 700 to 1,000 tons of copper a month, and the Miami mine closedown a loss of 700 tons a month.

Lead and zinc were spotty. One leading custom smelter sold fair amounts of lead and zinc during the week to their regular customers for March delivery on an average price basis, but the sales were considered late covering needs.

The General Services Administration came in for February tonnage and took about 5,000 tons of lead, but only about 7,000 tons of zinc instead of its recent 10,000 tons quantity, reliable sources said. These sources guessed that the G.S.A. funds were running out, and the Agency was trying to spread its remaining money as thinly as possible.

Tin softened in early dealings but steadied later in sympathy with foreign centres. Business transacted was negligible, with the trade keenly awaiting the result of the March International Tin Council meeting.

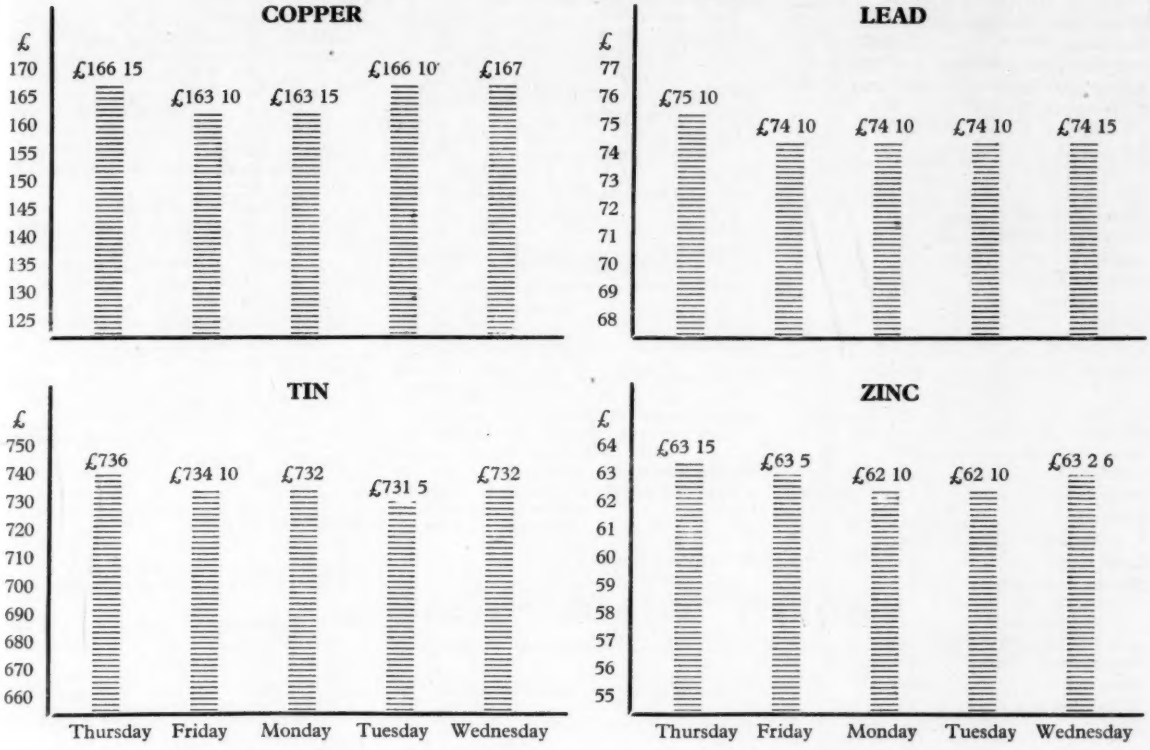
Paris

The private financial company "Petrofigaz" last week floated a 9,000 million francs loan to finance the building of an aluminium plant using as power natural gas from the deposit at Lacq, in south-western France. The project, the first to use the Lacq gas for industrial purposes, aims at adding another 75,000 tons by 1960 to France's aluminium output, which now works at the annual peak capacity of 160,000 tons. Of this, 50,000 tons will be produced by a plant now built by Péchinéy near Lacq, and 25,000 tons in the Pyrenees by increasing the Lannemezan plant's capacity. This plant belongs to France's second aluminium producer, Uginé.

Petrofigaz was formed by the Union Europeenne Industrielle et Financiere and Banque de Paris et des Pays-Bas, the French Gas Corporation, a number of other banks, Compagnie du Canal de Suez, Péchinéy, Uginé, and other industrial companies. The Lacq gas will be sold at a very low price so that aluminium can be produced on competitive terms. This aluminium will meet higher domestic consumption, expected to increase to 220,000 tons by 1961 and to 280,000 tons by 1965. The Lacq project is expected to help tide French industry over until the African projects of Konkoure and Kouilou (in French Guinea and in the Middle Congo respectively) go into production.

METAL PRICE CHANGES

LONDON METAL EXCHANGE, Thursday 6 March 1958 to Wednesday 12 March 1958



OVERSEAS PRICES

Latest avaliable quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏ £/ton	Canada c/lb ≏ £/ton	France fr/kg ≏ £/ton	Italy lire/kg ≏ £/ton	Switzerland fr/kg ≏ £/ton	United States c/lb ≏ £/ton
Aluminium		24.63 203 10	210 182 15	400 232 0	2.50 209 0	28.10 224 17 6
Antimony 99.0			195 169 12 6	430 249 10		29.00 232 0
Cadmium			1,400 1,218 0	2,550 1,479 0		155.00 1,240 0
Copper						
Crude						
Wire bars 99.9				340 197 5		
Electrolytic	23.00 168 2 6	24.50 202 7 6	213 185 7 6		2.00 167 5	25.00 200 0
Lead		12.25 101 2 6	123 107 0	182 105 10	.95 79 10	13.00 104 0
Magnesium						
Nickel		71.50 590 10	1,205 104 17 6	1,330 771 10	7.70 643 17 6	74.00 592 0
Tin	103.25 754 15		904 786 10	1,420 823 12 6	8.77 733 7 6	94.62 757 0
Zinc						
Prime western		10.00 82 12 6				10.00 80 0
High grade 99.95		10.60 87 10 0				
High grade 99.99		11.00 90 5				
Thermic			107.12 93 2 6			
Electrolytic			115.12 100 2 6	157 91 0	.82 68 10	11.75 94 0

NON-FERROUS METAL PRICES

(All prices quoted are those available at 12 noon 12/3/58)

PRIMARY METALS

	£	s.	d.
Aluminium Ingots.... ton	197	0	0
Antimony 99·6% .... „	197	0	0
Antimony Metal 99%.. „	190	0	0
Antimony Oxide..... „	180	0	0
Antimony Sulphide Lump..... „	190	0	0
Antimony Sulphide Black Powder..... „	205	0	0
Arsenic..... „	400	0	0
Bismuth 99·95%..... lb.		16	0
Cadmium 99·9% .... „		10	0
Calcium..... „	2	0	0
Cerium 99%..... „	13	18	0
Chromium..... „		6	11
Cobalt..... „		16	0
Columbite.... per unit		—	
Copper H.C. Electro.. ton	167	0	0
Fire Refined 99·70% „	166	0	0
Fire Refined 99·50% „	165	0	0
Copper Sulphate.... „	64	0	0
Germanium..... grm.		—	
Gold..... oz.	12	9	2¾
Indium..... „		10	0
Iridium..... „	27	0	0
Lanthanum.....grm.		15	0
Lead English..... ton	74	15	0
Magnesium Ingots.... lb.		2	5½
Notched Bar..... „		2	10½
Powder Grade 4..... „		6	3
Alloy Ingot, A8 or AZ91 „		2	8
Manganese Metal.... ton	300	0	0
Mercury.....flask	77	0	0
Molybdenum..... lb.	1	10	0
Nickel..... ton	600	0	0
F. Shot..... lb.		5	5
F. Ingot..... „		5	6
Osmium..... oz.		nom.	
Osmiridium..... „		nom.	
Palladium..... „	7	10	0
Platinum..... „	26	15	0
Rhodium..... „	40	0	0
Ruthenium..... „	16	0	0
Selenium..... lb.		nom.	
Silicon 98%..... ton		nom.	
Silver Spot Bars..... oz.		6	4¼
Tellurium..... lb.		15	0
Tin..... ton	732	0	0
Titanium..... lb.		19	6
***Zinc**			
Electrolytic..... ton		—	
Min 99·99%..... „		—	
Virgin Min 98%.... „	63	3	9
Dust 95/97%..... „	104	0	0
Dust 98/99%..... „	110	0	0
Granulated 99+% .. „	88	3	9
Granulated 99·99+% „	101	0	0

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

Aluminium Alloy (Virgin)	£	s.	d.
B.S. 1490 L.M.5 .... ton	227	0	0
B.S. 1490 L.M.6 .... „	217	0	0
B.S. 1490 L.M.7 .... „	231	0	0
B.S. 1490 L.M.8 .... „	220	0	0
B.S. 1490 L.M.9 .... „	218	0	0
B.S. 1490 L.M.10.... „	236	0	0
B.S. 1490 L.M.11.... „	231	0	0
B.S. 1490 L.M.12.... „	240	0	0
B.S. 1490 L.M.13.... „	231	0	0
B.S. 1490 L.M.14.... „	241	0	0
B.S. 1490 L.M.15.... „	227	0	0
B.S. 1490 L.M.16.... „	222	0	0
B.S. 1490 L.M.18.... „	220	0	0
B.S. 1490 L.M.22.... „	228	0	0

	£	s.	d.
†**Aluminium Alloy (Secondary)**			
B.S. 1490 L.M.1 .... ton	155	0	0
B.S. 1490 L.M.2 .... „	161	0	0
B.S. 1490 L.M.4 .... „	183	0	0
B.S. 1490 L.M.6 .... „	205	0	0
†Average selling prices for January			
***Aluminium Bronze**			
BSS 1400 AB.1..... ton	198	0	0
BSS 1400 AB.2..... „		—	
***Brass**			
BSS 1400-B3 65/35 .. „	121	0	0
BSS 249..... „		—	
BSS 1400-B6 85/15.. „	162	0	0
***Gunmetal**			
R.C.H. 3/4% ton... ton		—	
(85/5/5/5).....	148	0	0
(86/7/5/2)..... „	159	0	0
(88/10/2/1)..... „	204	0	0
(88/10/2/½)..... „	207	0	0
Manganese Bronze			
BSS 1400 HTB1.... „	169	0	0
BSS 1400 HTB2.... „		—	
BSS 1400 HTB3.... „	185	0	0
Nickel Silver			
Casting Quality 12% „		nom.	
„ „ 16% „		nom.	
„ „ 18% „		nom.	
***Phosphor Bronze**			
2B8 guaranteed A.I.D. released..... „	230	0	0
Phosphor Copper			
10%..... „	198	0	0
15%..... „	208	0	0
Phosphor Tin			
5%..... ton		—	
Silicon Bronze			
BSS 1400-SB1..... „		—	
Solder, soft, BSS 219			
Grade C Tinmans.... „	347	0	0
Grade D Plumbers .. „	281	3	0
Grade M..... „	379	9	0
Solder, Brazing, BSS 1845			
Type 8 (Granulated) lb.		—	
Type 9 „ „		—	
Zinc Alloys			
Mazak III..... ton	94	5	0
Mazak V..... „	98	5	0
Kayem..... „	104	5	0
Kayem II..... „	110	5	0
Sodium-Zinc..... lb.		2	5

*Average prices for the last week-end.

SEMI-FABRICATED PRODUCTS

Prices of all semi-fabricated products vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium	£	s.	d.
Sheet 10 S.W.G. lb		2	9
Sheet 18 S.W.G. „		2	11
Sheet 24 S.W.G. „		3	2
Strip 10 S.W.G. „		2	9
Strip 18 S.W.G. „		2	10
Strip 24 S.W.G. „		2	11½
Circles 22 S.W.G. „		3	3
Circles 18 S.W.G. „		3	2
Circles 12 S.W.G. „		3	1
Plate as rolled..... „		2	8½
Sections..... „		3	2½
Wire 10 S.W.G..... „		3	0
Tubes 1 in. o.d. 16 S.W.G. ..... „		4	1

	£	s.	d.
Aluminium Alloys			
BS1470. HS10W. lb.			
Sheet 10 S.W.G. „		3	1½
Sheet 18 S.W.G. „		3	4
Sheet 24 S.W.G. „		3	11½
Strip 10 S.W.G. „		3	1½
Strip 18 S.W.G. „		3	3
Strip 24 S.W.G. „		3	11
BS1477 HP30M. Plate as rolled.....		2	11½
BS1470. HC15WP.			
Sheet 10 S.W.G. lb.		3	9½
Sheet 18 S.W.G. „		4	1½
Sheet 24 S.W.G. „		4	11½
Strip 10 S.W.G. „		3	10½
Strip 18 S.W.G. „		4	1½
Strip 24 S.W.G. „		4	9
BS1477. HPC15WP. Plate heat treated.. „		3	6½
BS1475. HG10W. Wire 10 S.W.G. „		3	10½
BS1471. HT10WP Tubes 1 in. o.d. 16 S.W.G. ..... „		5	0
BS1476. HE10WP. Sections..... „		3	2
Beryllium Copper			
Strip..... „	1	4	11
Rod..... „	1	1	6
Wire..... „	1	4	9
Brass Tubes..... „		1	4½
Brazed Tubes..... „		—	
Drawn Strip Sections „		—	
Sheet..... ton		—	
Strip..... „	199	15	0
Extruded Bar..... lb.		1	7½
Extruded Bar (Pure Metal Basis) ..... „		—	
Condenser Plate (Yellow Metal)..... ton	140	0	0
Condenser Plate (Naval Brass) ..... „	151	0	0
Wire..... lb.		2	2½
Bronze Sheet and Strip ton		—	
Copper Tubes..... lb.		1	7½
Sheet..... ton	189	10	0
Strip..... „	189	10	0
Plain Plates..... „		—	
Locomotive Rods .... „		—	
H.C. Wire..... „	214	5	0
Cupro Nickel			
Tubes 70/30..... lb.		3	1½
Lead Pipes (London) .. ton	115	5	0
Sheets (London) .... „	113	0	0
Tellurium Lead..... „	£6 extra		
Nickel Silver			
Rods..... lb.		—	
Sheet and Strip 7%.. „		3	2
Wire 10%..... „		3	8½
Phosphor Bronze			
Wire..... „		3	4½
Titanium			
Billet..... lb.	4	10	0
Sheet..... „	6	12	0
Wire..... „	9	10	0
Tube..... „	16	0	0
Zinc Sheets, English destinations..... ton	97	10	0
Strip..... „		nom.	

Financial News

Light Metal Statistics

Figures showing the U.K. production, etc., of light metals for Dec., 1957, have been issued by the Ministry of Supply as follow (in long tons):—

Virgin Aluminium	
Production	2,780
Imports	19,479
Despatches to consumers	20,233
Secondary Aluminium	
Production	8,545
Virgin content of above	1,102
Despatches (including virgin content)	8,494
Secondary in Consumption (per cent)	
Wrought products	4·3
Cast products	82·2
Destructive uses (aluminium content irrecoverable)	74·3
Total consumption	28·4
Scrap	
Arisings	11,366
Estimated quantity of metal recoverable	8,164
Consumption by:	
(a) Secondary smelters	9,818
(b) Other users	1,128
Despatches of wrought and cast products	
Sheet, strip and circles	11,416
Extrusions (excluding forging bar, wire-drawing rod and tube shell):	
(a) Bars and sections	2,374
(b) Tubes (i) extruded	324
(ii) cold drawn	569
(c) (i) Wire	1,226
(ii) Hot rolled rod (not included in (c) (i)	48
Forgings	332
Castings: (a) Sand	1,609
(b) Gravity die	3,664
(c) Pressure die	1,512
Foil	1,738
Paste	245
Magnesium Fabrication	
Sheet and strip	6
Extrusions	14
Castings	184
Forgings	7

Aluminium Corporation

Trading profit for 1957, £204,179 (£218,487), investment income £1,600 (£2,040). To depreciation £22,033 (£22,756), directors' emoluments £16,822 (£17,712), debenture interest nil (£1,400), audit £520 (£562), tax £83,500 (£89,575), net profit £82,904 (£88,522). To pensions £20,000 (£25,000), stock prices reserve nil (£10,000), general reserve £30,000 (same), dividend 17½ per cent (same), forward £39,472 (£36,755, including £9,840 tax adjustment).

Follsain-Wycliffe Foundries

Final dividend 10 per cent, making 17½ per cent on larger capital for 1957 (same on smaller capital). Consolidated net profit is £33,075 (£32,341), after estimated tax of £26,800 (£25,500). To revenue reserve £20,000 (£15,000), capital reserve £11,289 (nil), forward £23,705 (£33,842).

Thermal Syndicate

After depreciation £42,202 (£37,160), taxes £103,808 (£88,590), etc., group net profit year to October 31, 1957, is £99,825 (£89,548). To reserves, £44,898 (£46,114). Ordinary dividend 25 per cent (same), forward £84,044 (£46,663). Current assets £606,841 (£519,601), liabilities £228,387 (£219,890), future tax £68,344 (£68,223), and loan capital £66,521 (£73,647). Commitments £26,787.

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons, Limited, Company Registration Agents, Chancery Lane, W.C.2.

Express Welding Company Limited (597333), The Forge, Blindley Heath, Surrey. Registered January 17, 1958. To take over business carried on as "Mobile Welding Company" at Blindley Heath, Surrey, etc. Nominal capital, £100 in £1 shares. Permanent directors: R. W. Rignall and H. McLaughlan.

Samuel Langton and Sons Limited (597357), Mersey Brass Works, Heaton Lane, Stockport. Registered January 17, 1958. To take over business of brass founders carried on at Stockport as "Samuel Langton and Sons," etc. Nominal capital, £15,000 in £1 shares. Directors: S. Langton, Mrs. D. Langton and H. Evans.

Castings and Smelters Ltd. (597411), 173 Walsall Road, Cannock, Staffs. Registered January 20, 1958. Nominal capital, £5,000 in £1 shares. Director: Gladys E. Oakley.

Chanter and Harding Limited (597414), No. 1 Carters Factories, Alexandra Road, Ponders End, Middx. Registered January 20, 1958. To carry on business of metal and alloy makers and refiners, etc. Nominal capital, £1,000 in £1 shares. Directors: A. E. Chanter and J. J. Harding.

Leyswood Metal Workers Limited (597532), 31 Leyswood Drive, Ilford. Registered January 21, 1958. Nominal capital, £100 in £1 shares. Directors: L. E. Parker and E. M. Pratt.

Welduct Metals Limited (597828), 61 Carey Street, W.C.2. Registered January 24, 1958. To carry on business of manufacturers of and dealers in aluminium sheeting and aluminium building components, etc. Nominal capital, £500 in £1 shares. Directors: A. Lee and Laura E. Trimmer.

Scrap Metal Prices

Merchants' average buying prices delivered, per ton, 11/3/58.

	£
Aluminium	
New Cuttings	160
Old Rolled	130
Segregated Turnings	100
Brass	
Cuttings	105
Rod Ends	102
Heavy Yellow	85
Light	80
Rolled	95
Collected Scrap	82
Turnings	96
Copper	
Wire	136
Firebox, cut up	136
Heavy	130
Light	125
Cuttings	136
Turnings	119
Braziery	109
Gunmetal	
Gear Wheels	140
Admiralty	140
Commercial	116
Turnings	111
Lead	
Scrap	65/10
Nickel	
Cuttings	—
Anodes	525
Phosphor Bronze	
Scrap	116
Turnings	111
Zinc	
Remelted	—
Cuttings	39
Old Zinc	27

The latest available scrap prices quoted on foreign markets are as follow. (The figures in brackets give the English equivalents in £1 per ton):—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£143.10.0)	165
Heavy copper	(£143.10.0)	165
Light copper	(£121.17.6)	140
Heavy brass	(£91.7.6)	105
Light brass	(£65.5.0)	75
Soft lead scrap	(£56.10.0)	65
Zinc scrap	(£39.2.6)	45
Used aluminium unsorted	(£82.12.6)	95
France (francs per kilo):		
Copper	(£187.0.0)	215
Heavy copper	(£187.0.0)	215
Light brass	(£134.17.6)	155
Zinc castings	(£64.7.6)	74
Tin	(£565.10.0)	650
Aluminium pans (98½ per cent)	(£130.10.0)	150
Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£194.7.6)	335
Aluminium copper alloy	(£104.10.0)	180
Lead, soft, first quality	(£87.0.0)	150
Lead, battery plates	(£52.5.0)	90
Copper, first grade	(£159.10.0)	275
Copper, second grade	(£148.0.0)	255
Bronze, first quality machinery	(£162.10.0)	280
Bronze, commercial gunmetal	(£133.10.0)	230
Brass, heavy	(£110.5.0)	190
Brass, light	(£98.12.6)	170
Brass, bar turnings	(£113.2.6)	195
New zinc sheet clippings	(£55.2.6)	95
Old zinc	(£40.12.6)	70

THE STOCK EXCHANGE

Prices Continue To Improve Slowly And Business Slightly Better In Places

ISSUED CAPITAL •	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 11 MARCH	+RISE —FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1958 HIGH	1958 LOW	1957 HIGH	1957 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	18/–	+3d.	10	10	11 2 3	19/9	17/9	28/3	18/–
400,000	2/–	Anti-Attrition Metal	1/6		8½	7½	11 6 9	1/6	1/3	2/6	1/6
33,639,483	Stk. (£1)	Associated Electrical Industries ...	50/9	+2/–	15	15	5 18 3	50/9	47/–	72/3	47/9
1,590,000	1	Birfield Industries	50/6	+6d.	15	20N	5 18 9	53/9	50/–	70/–	48/9
3,196,667	1	Birmid Industries	56/3		17½	17½	6 4 3	57/9	56/3	80/6	55/9
5,630,344	Stk. (£1)	Birmingham Small Arms	24/–	—6d.	10	8	8 6 9	26/7½	24/–	33/–	21/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	14/7½		5	5	6 16 9	15/–	14/7½	16/–	15/–
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	16/10½		6	6	7 2 3	17/–	16/6	19/–	16/6
500,000	1	Bolton (Thos.) & Sons	26/10½		12½	12½	9 6 0	28/9	26/10½	30/3	28/9
300,000	1	Ditto Pref. 5%	15/3		5	5	6 11 3		—	16/9	14/3
160,000	1	Booth (James) & Co. Cum. Pref. 7%	19/–		7	7	7 7 3		—	22/3	18/9
9,000,000	Stk. (£1)	British Aluminium Co.	45/6	+9d.	12	12	5 5 5	45/6	41/3	72/–	38/3
1,500,000	Stk. (£1)	Ditto Pref. 6%	19/–		6	6	6 6 3	19/3	18/4½	21/6	18/–
15,000,000	Stk. (£1)	British Insulated Callender's Cables	39/6		12½	12½	6 6 6	42/–	38/10½	55/–	40/–
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord ...	32/–	+1/6	10	10	6 5 0	32/3	29/–	39/–	29/6
600,000	Stk. (5/–)	Canning (W.) & Co.	20/9		25	25	6 0 6	20/9	20/1½	24/6	19/3
60,484	1/–	Carr (Chas.)	2/1½		25	25	X 8 4 9	2/3	2/–	3/6	2/1½
150,000	2/–	Case (Alfred) & Co. Ltd.	4/4½		25	25	11 8 6	4/9	4/4½	4/6	4/–
555,000	1	Clifford (Chas.) Ltd.	16/4½	+1½d.	10	15N	12 4 3	16/6	16/–	20/6	15/9
45,000	1	Ditto Cum. Pref. 6%	15/10½		6	6	7 11 3		—	17/6	16/–
250,000	2/–	Coley Metals	3/6		25	25	14 5 9	4/6	3/6	5/7½	3/9
8,730,596	1	Cons. Zinc Corp.†	47/–	+3/–	22½	22½	9 11 6	51/6	43/–	92/6	49/–
1,136,233	1	Davy & United	46/3		15	12½	6 6 3	48/–	46/3	60/6	42/6
2,750,000	5/–	Delta Metal	19/10½	+1½d.	•17½	•17½	4 8 0	21/4½	19/7½	28/6	19/–
4,160,000	Stk. (£1)	Enfield Rolling Mills Ltd.	26/–	+2/–	15B	22½	9 12 3	26/6	24/–	38/6	25/–
500,000	1	Evered & Co.	40/–		15	15	7 10 0	41/3	40/–	52/9	42/–
18,000,000	Stk. (£1)	General Electric Co.	30/6		12½	14	Y 7 10 9	38/7½	30/1½	59/–	38/–
1,250,000	Stk. (10/–)	General Refractories Ltd.	32/–	+2/9	20	17½	6 5 0	32/–	27/3	37/–	26/9
401,240	1	Gibbons (Dudley) Ltd.	65/6	—9d.	15	12	4 11 9	66/3	64/–	71/–	53/–
750,000	5/–	Glacier Metal Co. Ltd.	5/9		11½	11½	10 0 0	6/–	5/7½	8/1½	5/10½
1,750,000	5/–	Glynwed Tubes	13/4½		20	20	7 9 6	13/6	12/10½	18/–	12/6
3,614,032	10/–	Goodlass Wall & Lead Industries ...	28/–		18	16	6 8 6	29/9	28/–	37/3	28/9
342,195	1	Greenwood & Batley	46/10½		17½	17½	7 9 3		—	50/–	46/–
396,000	5/–	Harrison (B'ham) Ord.	12/4½	+10½d.	•15	•30‡	6 1 3	12/4½	11/6	16/9	12/4½
150,000	1	Ditto Cum. Pref. 7%	18/9		7	7	7 9 3		—	22/3	18/7½
1,075,167	5/–	Heenan Group	7/3	+3d.	10	20‡	6 18 0	7/7½	6/9	10/4½	6/9
142,045,750	Stk. (£1)	Imperial Chemical Industries ...	39/–	+6d.	10	10	5 2 6	39/10½	36/6	46/6	36/3
33,708,769	Stk. (£1)	Ditto Cum. Pref. 5%	16/3	—3d.	5	5	6 3 0	17/1½	16/–	18/6	15/6
14,584,025	••	International Nickel	144½	+6½	$3.75	$3.75	4 13 6	144½	136½	222	130
430,000	5/–	Jenks (E. P.), Ltd.	7/7½xcap		27½ ϕ	27½	9 0 3	7/9½	7/3	18/10½	15/1½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	15/–		5	5	6 13 3		—	17/–	14/6
3,987,435	1	Ditto Ord.	39/9	+2/3	10	9	5 0 9	41/3	37/6	58/9	40/–
600,000	10/–	Keith, Blackman	16/3		15	15	9 4 6	16/3	15/–	21/9	15/–
160,000	4/–	London Aluminium	3/7½	—1½d.	10	5	11 0 9	4/3	3/6	6/9	3/6
2,400,000	1	London Elec. Wire & Smith's Ord....	39/9		12½	12½	6 5 9	41/9	39/9	54/6	41/–
400,000	1	Ditto Pref.	22/9		7½	7½	6 11 9		—	25/3	21/9
765,012	1	McKechnie Brothers Ord.	35/–		15	15	8 11 6		—	48/9	37/6
1,530,024	1	Ditto A Ord.	32/6		15	15	9 4 6		—	47/6	36/–
1,108,268	5/–	Manganese Bronze & Brass	9/–		27½‡	25	7 12 9	9/6	9/–	21/10½	7/6
50,628	6/–	Ditto (7½% N.C. Pref.)	5/9		7½	7½	7 16 6		—	6/6	5/–
13,098,855	Stk. (£1)	Metal Box	44/–	+1/10½	20‡	15M	4 11 0	44/–	41/9	59/–	40/3
415,760	Stk. (2/–)	Metal Traders	6/3		50	50	16 0 0	6/6	6/3	8/–	6/3
160,000	1	Mint (The) Birmingham	22/–		10	10	9 1 9	22/9	22/–	25/–	21/6
80,000	5	Ditto Pref. 6%	83/6		6	6	7 3 9		—	90/6	83/6
3,064,930	Stk. (£1)	Morgan Crucible A	37/–	+3/–	10	11	5 8 0	37/–	34/–	54/–	35/–
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/3		5½	5½	6 7 6	17/3	17/–	19/3	16/–
2,200,000	Stk. (£1)	Murex	54/3	+6d.	20	20	7 7 6	57/6	53/9	79/9	57/–
468,000	5/–	Ratcliffs (Great Bridge) ...	7/1½		10	10	7 0 3	7/1½	6/10½	8/–	6/10½
234,960	10/–	Sanderson Bros. & Newbould ...	27/–		27½D	27½	6 15 9	27/–	26/–	41/–	24/9
1,365,000	Stk. (5/–)	Serck Radiators	11/–		17½Z	15	5 6 0	12/–	11/–	18/10½	11/6
600,400	Stk. (£1)	Stone (J.) & Co. (Holdings) ...	43/9		16	16	7 6 6		—	57/6	43/9
600,000	1	Ditto Cum. Pref. 6½%	20/–		6½	6½	6 10 0		—	21/9	18/9
14,494,862	Stk. (£1)	Tube Investments Ord.	51/9	+1/9	15	15	5 16 0	53/9	48/4½	70/9	50/6
41,000,000	Stk. (£1)	Vickers	30/–	—1½d.	10	10	6 13 3	31/–	29/4½	46/–	29/–
750,000	Stk. (£1)	Ditto Pref. 5%	15/6		5	5	6 9 0	15/6	14/9	18/–	14/–
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	22/6		•5	•5	6 17 0A	23/–	21/3	24/9	20/7½
2,200,000	1	Ward (Thos. W.), Ord.	73/6	+9d.	20	15	5 8 9	73/6	70/9	83/–	64/–
2,666,034	Stk. (£1)	Westinghouse Brake	35/9	+6d.	10	18P	5 12 0	36/3	32/6	85/–	29/1½
225,000	2/–	Wolverhampton Die-Casting ...	7/6		25	40	6 13 3	7/9	7/2½	10/1½	7/–
591,000	5/–	Wolverhampton Metal	15/–	—3d.	27½	27½	9 3 3	15/6	14/9	22/3	14/9
78,465	2/6	Wright, Bindley & Gell	3/3	—1½d.	20	17½E	15 7 9	3/9½	3/3	3/9	2/7½
124,140	1	Ditto Cum. Pref. 6%	11/6		6	6	10 8 9		—	12/6	11/3
150,000	1/–	Zinc Alloy Rust Proof	2/10½		40D	33½	9 5 6	3/1½	2/7½	5/–	2/9

•Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting. ••Shares of no Par Value. ‡ and 100% Capitalized issue. • The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. H and 200% capitalized issue. M and 10% capitalized issue. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. E for 15 months. P and 100% capitalized issue, also "rights" issue of 2 new shares at 35/– per share or £3 stock held. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. ϕ And 100% capitalized issue. X Calculated on 17½%.